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Title: Alignment Development Report Caliente Rail Corridor

Supplier Document #: NRP-R-SYSW-DA-0001-03

Supplier Rev.: 03

Supplier Date: 05/15/07

Reference #: NVT-CD-00162

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Responsible Individual: <u>Eugene Allen</u> Name (Print)		EA Initials	<u>423</u> Mailstop	<u>6/15/07</u> Date	<u>6/21/07</u> Due Date

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Subcontractor: Nevada Rail Partners	Item Number/Title/Revision: T6/Route Alignment Definition – Alignment Development Report, Caliente Rail Corridor – NRP-R-SYSW-DA-0001-03, Rev.03, Exhibit I, Item Number 10t, RFP Reference Exhibit D-2.6a.11	Submittal Date: May 15, 2007	SRCT No.: 06-00024
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Section I. Submittal Information (includes above information)

Submittal Description and Revision Summary for Entire Submittal:

We are submitting the final edition of Alignment Development Report, Caliente Rail Corridor, including narrative text and figures, and six (6) appendices labeled A through F. The document included in this submittal is revised from the previous Rev. 02A submittal in January 2007. The redline changes submitted as Rev. 02A of this document have been accepted by BSC. The new changes shown in the PDF file containing the Rev. 03 redlines resulted from the comment resolution process for the Rev. 02A submittal.

In addition, changes to the Beatty Wash and Busted Butte alignments were submitted in 2006 as part of the final plan and profile sheets. These alignment changes resulted in earthwork changes to CS6 and BC3 that are reflected in this Rev. 03 submittal.

The purpose of the alignment report is to document the activities completed to develop feasible, engineered alignments for multiple segments of rail line within the Caliente Rail Corridor. The report describes the basis of alignment development (including assumptions and data sources), the process, and presents findings in terms of engineering data for each of the alignment segments.

Special Instructions:

All files can be printed in their entirety.

Section II. Data File Information (Add lines below if needed for additional files. Indicate "Last item" or "End of list" on last line used.)

Filename	Rev.	File Size	Description (File description and revision summary for file)	Application and Version/ Add-in or Extension and Version
T6-Cover.doc	03	708 KB	Report cover for Alignment Development Report, Caliente Rail Corridor - NRP-R-SYSW-DA-0001-03, Rev.03	Microsoft Powerpoint 2003
T6_CRCAAlignme ntDevelopmentRe port_FINAL_Rev 03_15May07.doc	03	6,667 KB	Main text with all graphics and appendices - Alignment Development Report, Caliente Rail Corridor - NRP-R-SYSW-DA-0001-03, Rev.03	Microsoft Word 2003
T6_CRCAAlignme ntDevelopmentRe port_FINAL_Rev 03_15May07.pdf	03	3,297 KB	Scanned final version of the complete document with all imbedded graphics and appendices - Alignment Development Report, Caliente Rail Corridor - NRP-R-SYSW-DA-0001-03, Rev.03	Adobe Acrobat 7.0 Standard Version
T6_CRCAAlignme ntDevelopmentRe port_FINALRead only_Rev03_15M ay07.doc	03	6,625 KB	Main text (Read Only) with all graphics and appendices - Alignment Development Report, Caliente Rail Corridor - NRP-R-SYSW-DA-0001-03, Rev.03	Microsoft Word 2003
T6_CRCAAlignme ntDevelopmentRe port_FINALredlin es_Rev03_15May 07.pdf	03	2,753 KB	Scanned redline version of the complete document with all imbedded graphics and appendices - Alignment Development Report, Caliente Rail Corridor - NRP-R-SYSW-DA-0001-03, Rev.03	Adobe Acrobat 7.0 Standard Version
*****Last Item*****				

Section III. Metadata

☐ GIS Metadata

All GIS data is preferred in ArcGIS9.1 UTM, NAD1983, Zone11, Feet.

Projection:

Datum:

Zone:

Units:

☐ CAD Metadata

Level descriptions:

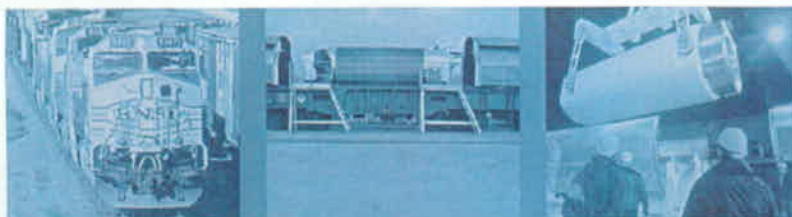
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Subcontractor: Nevada Rail Partners	Item Number/Title/Revision: T6/Route Alignment Definition – Alignment Development Report, Caliente Rail Corridor – NRP-R-SYSW-DA-0001-03, Rev.03, Exhibit I, Item Number 10t, RFP Reference Exhibit D- 2.6a.11	Submittal Date: May 15, 2007	SRCT No.:
CAD drawings are preferred in Bentley MicroStation V8 and/or InRoads and should adhere to established CAD standards .	Scale:		
	Units of Measurement:		
	Horizontal and Vertical Datum:		
Section IV. Data Screening (Completed by BSC personnel)			
Suitable for Review? <input checked="" type="checkbox"/> Yes* <input type="checkbox"/> No	Screener Name: <i>Cathy Stettler</i>	Signature:	Date: <i>5/10/07</i>
*If "Yes", Data Storage Location: <i>NYTdata\NRP\Task 6 Route Alignment Definition\06-10024 Route Align Def</i>			
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Section V. STR Disposition of Submittal			
Process for Review? <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No**	** If "No", date returned:	Comments:	
STR Name: <i>Gene Allen</i>	Signature: <i>Gene Allen</i> <i>5/10/07</i>	Date: <i>5/10/07</i>	



Alignment Development Report Caliente Rail Corridor

Task 6: Route Alignment Definition

REV. 03

Document No. NRP-R-SYSW-DA-0001-03

Prepared by:



Prepared for:



Nevada Rail Line Conceptual Design

Subcontract NN-HC4-00239

May 15, 2007

Alignment Development Report Caliente Rail Corridor

Task 6: Route Alignment Definition

Rev. 03

Document No. NRP-R-SYSW-DA-0001-03

Nevada Rail Line Conceptual Design
Subcontract NN-HC4-00239
15 May 2007

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Appendix D - Engineering Findings

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List of Acronyms

3D	Three-Dimensional
ADT	Average Daily Traffic
ALW	Administrative Land Withdrawal
AREMA	American Railway Engineering and Maintenance-of-Way Association
BC	Bonnie Claire
BLM	Bureau of Land Management
BSC	Bechtel SAIC Company, LLC
BW	Beatty Wash
CAD	Computer-Aided Design
CRC	Caliente Rail Corridor
CS	Common Segment
DEIS	Draft Environmental Impact Statement
DOE	U.S. Department of Energy
EIS	Environmental Impact Statement
FEMA	Federal Emergency Management Agency
GIS	Geographic Information Systems
GF	Goldfield
GV	Garden Valley
lb.	Pound
NAD	North American Datum
NOI	Notice of Intent
NRL	Nevada Rail Line
NRP	Nevada Rail Partners
NTRD	<i>Nevada Transportation Requirements Document</i>
NTTR	Nevada Test and Training Range
mph	Miles per Hour
OV	Oasis Valley
POB	Point of Beginning
POE	Point of Ending
PVI	Point of Vertical Intersection
RA EIS	Rail Alignment Environmental Impact Statement
Repository	Yucca Mountain Geologic Repository
Rev.	Revision
ROD	Record of Decision
ROW	Right-of-Way

List of Tables, Figures, and Acronyms

SR	State Route
SR2 or SR3	South Reveille 2 or South Reveille 3
TIN	Triangulated Irregular Network
UPRR	Union Pacific Railroad
USGS	U.S. Geological Survey
UTM	Universal Transverse Mercator
WSA	Wilderness Study Area
YMP	Yucca Mountain Project

1.1 INTRODUCTION AND OBJECTIVE

One aspect of the Nevada Rail Line (NRL) conceptual design is an engineering development process for defining a railroad alignment that represents a feasible concept. This alignment forms a basis for final engineering, represents a concept that is constructible, and will support safe and practicable rail operations. This alignment also creates a basis for the comparative analysis of alternative alignments, and therefore supports the current rail alignment environmental impact statement (RA EIS) process.

NRL conceptual design has developed feasible, engineered alignments for multiple segments of rail line. Together, these individual segments create alternative alignments of a rail line between the existing national rail system near the town of Caliente, Nevada and the Yucca Mountain Geologic Repository (Repository), referred to as the Caliente Rail Corridor (CRC). The alignment development was conducted within an overall methodology, or framework, that governed the design and engineering activities. The framework included the definition of guiding parameters that bounded the design activities. The framework also defined a specific design process that was consistently applied to each individual segment of rail alignment. Finally, the framework provided a method for articulating the alignment development findings in terms that summarize the results of the design process and provide measurable criteria that differentiate between segment alternatives.

This report is one of several prepared to support and provide initial input to the first draft of the RA EIS. Each report covers a specific topic for a specific purpose. Accordingly, each report utilizes data from various sources in varying levels of detail and precision as appropriate, as well as in different contexts. While the reports are consistent in overall conceptual design, it is possible that numerical values for certain parameters may vary between the reports. This is result of the conceptual nature of the reports and their distinct areas of focus – it should not be considered an abnormal situation or an indication of error.

1.2 CONTENTS OF REPORT

Revision (Rev.) 0 (June 27, 2005) of this report was based in part upon an alignment developed using aerial mapping and contour data prepared and published by the U.S. Geological Survey (USGS). Subsequently, new aerial photography was obtained which provided greater resolution of the contours (5-foot contours) and topographic features within the CRC. These data were then used to refine the horizontal and vertical geometry of the Rev. 0 alignment. This new alignment is the engineering basis of Rev. 1 of this report.

The objective of this *Alignment Development Report* is to document the conceptual design framework and methodology that has led to the production of feasible, engineered alignments. The report describes three principal elements: the basis of the alignment development, the alignment development process, and the findings of the process. These elements are defined below, and described in subsequent sections of this report.

Basis of the Alignment Development: The report identifies the requirements, standards, previous activities, and design criteria that formed a framework that bounded the conceptual design. This bounding framework is comprised of geographic limits to the alignments, and input from institutional processes, technical standards, and established industry practices.

Alignment Development Process: A second section of this report's documentation describes the actual design process that was followed. This was the systematic process of steps that created feasible, engineered rail lines from the general routing defined by the CRC of the previous Repository environmental impact statement (EIS) (U.S. Department of Energy [DOE] 2002a), and the subsequent

refinement during the RA EIS scoping process (DOE 2006). A number of individual steps that constituted the design process are described in this report.

Alignment Development Findings: The development of feasible, engineered alignments has identified characteristics and defining parameters for both the CRC as well as for each of the individual segments. These specific findings are tabulated and described in this report.

This report's six appendices contain information that supports the three principle elements of the engineering development process.

- Appendix A – NRL Conceptual Design Technical Briefs
- Appendix B – Proposed NRL Design Criteria Basic Elements
- Appendix C – Quantm[®] Input Criteria
- Appendix D – Engineering Findings
- Appendix E – Engineering Parameters that Characterize Alignment Segments
- Appendix F – Alignment Narrative Reports

2.1 ALIGNMENT BOUNDARY CONDITIONS

The purpose of alignment development is to define feasible geometric alignments that will support a credible evaluation and impacts assessment. The basis of this effort was defined by guiding parameters (bounding conditions) stemming from previous DOE actions, current Yucca Mountain Project (YMP) program requirements, and ongoing conceptual design activities. These bounding conditions include:

- Engineered alignments prepared in 1997 as support to the Repository EIS
- Geographic limits of the CRC as described in the Repository EIS and the Administrative Land Withdrawal (ALW) petition to the Bureau of Land Management (BLM)
- General routing defined by DOE's RA EIS scoping process and subsequent alternatives-screening
- *Nevada Transportation Requirements Document* (NTRD) (BSC 2005)
- NRL Design Criteria (currently in draft status)
- Engineering data needs requested by EIS Team

1997 Engineered Alignments: The route segments identified as the CRC in the Repository EIS were developed into engineered alignments (the "MK Alignment"). This alignment was engineered based on criteria and requirements that considered and incorporated certain Class 1 freight railroad standards. The MK Alignment was developed to meet the following objectives:

- Minimize impacts to stakeholders
- Minimize impacts to areas of environmental concern
- Minimize and balance earthwork (cuts and fills) to yield a cost effective alignment
- Limit train transit time between Caliente and the Repository to allow transit by a single train crew in a 12-hour shift

The objectives of the 1997 rail engineering work were to identify potential rail corridors from various points on the existing rail system in Nevada to the Repository, and to formulate a possible alignment within these corridors. The analyses were performed on a broad level; hence, actual alignment details were based on very general criteria and purposely lacked specific details. A total of five different corridors were developed, as described in the Repository EIS (DOE 2002a).

The engineering data and geometric information from this previous activity were incorporated into the early actions of NRL conceptual design. However, three specific issues prevented continued use of this previously developed alignment as conceptual design progressed:

- The MK Alignment was defined by geometry inconsistent with the current requirements and design criteria established for the NRL (Table 2-1).
- The EIS scoping process identified several route segments that were significantly modified from the MK Alignment and identified other segments that were not components of the MK Alignment.
- The background mapping for the MK Alignment contained topographic discrepancies and did not represent a credible basis for continued development.

Of the information listed in Table 2-1, the factor having the greatest impact on alignment is the decision to provide flatter curves. By reducing curvature, long-term operation and maintenance costs can be reduced, and overall system operating characteristics are improved. From Table 2-1, it is noted that the current concept provides a more robust design.

2.0 Basis of Alignment Development

Table 2-1. Comparison of Engineering Criteria Used in Early Stages of Project Formulation to Current Criteria Proposed by NRL.

Parameter	Criteria Used for Repository EIS	Criteria Used for RA EIS
Horizontal curvature (maximum)	8.73 degrees	6.00 degrees
Grades (maximum)	2.0 percent uncompensated for curvature	2.0 percent compensated for curvature
Speed, in miles per hour (mph)	60	60
Track section	115-lb. rail timber ties 6 – 12 inches of ballast light density rail traffic	136-lb. rail concrete ties 12 inches of ballast 18 inch ballast shoulder

CRC and the ALW: The Repository EIS described five corridors for rail-line locations. These rail lines would connect with the national rail system and thus provide an avenue for transporting spent nuclear fuel and high-level radioactive waste from the commercial reactors and from defense facilities. Of the five corridors described in the Repository EIS, the DOE's Record of Decision (ROD) (FR Vol. 68, No. 248, 29 December 2003) stated that the CRC was the preferred alternative. In the ROD, the CRC was defined as "a strip of land, approximately 0.25 mile (400 meters) wide that encompasses one of several possible routes through which DOE could build a rail line."

Over 99 percent of the CRC lies on public lands administered by the BLM. Concurrently with the publication of the ROD, the BLM filed notice in the Federal Register that the DOE had petitioned to withdraw land from surface entry and mining for a period of 20 years to evaluate the land for the potential construction, operation, and maintenance of a rail line. The width of the land withdrawal is one mile, and contains the CRC as defined in the Repository EIS.

These two definitions of geographic location, the CRC and the BLM ALW, form the horizontal boundaries for conceptually designing the segments. However, these boundaries were not considered absolute; when feasibility directed the alignment otherwise, the alignments shifted outside the limits of the CRC and the ALW. A third geographic consideration, private property, will be investigated as design continues.

Input from Scoping and Screening: Following the publication of the ROD and the Notice of Intent (NOI), the DOE held a series of scoping meetings in Las Vegas, Amargosa Valley, Goldfield, and Reno, Caliente. The DOE also solicited written comments from the public regarding the intent to prepare the RA EIS for the CRC. This scoping process resulted in the identification of numerous, alternative route segments that included segments of the MK Alignment, modified versions of the MK Alignment, and entirely new segments. These numerous segments were subjected to a screening process (to be described in RA EIS Appendix I) and certain segments were eliminated from further consideration. Segments that remained were designated for detailed analysis and evaluation, and this set of segments defined the activities of conceptual design.

NTRD (BSC 2005): The purpose of the NRL is to provide a means of transporting spent nuclear fuel and high-level radioactive waste to the Repository. A secondary purpose of the NRL is to provide construction materials to the Repository and to support Repository operations. DOE has identified specific functional requirements and criteria for design and operation of the NRL. These concepts establish the weight limits for structural loading of the track and bridges, as well as the overall train

2.0 Basis of Alignment Development

consists required for determining horsepower, and braking requirements. These program requirements were taken in part from the DOE's *Integrated Interface Control Document, Volume 1* (DOE 2002b). These considerations are important to the formulation of specific criteria for design and operation of the NRL.

Early conceptual design activities considered several topics important to the development of the rail line. These topics included train consists, fencing, access roads, and grades. Of these topics, grades are of critical importance to alignment development and form one of the boundary conditions in the conceptual design process. This technical brief is reproduced in Appendix A.

NRL Design Criteria: Design criteria have been prepared defining the technical design basis that must be achieved by the conceptual design. These criteria are based on requirements found in the NTRD, which defines the safety and functional requirements associated with waste transport.

These criteria have been developed in coordination with established practices of the national rail system and railroad companies, with industry guidelines such as those published by the American Railway Engineering and Maintenance of Way Association (AREMA), and with other professional associations of the railroad industry. For example, a primary requirement of the NRL calls for a desired design speed of 60 mph. This requirement established limits of horizontal geometry and vertical grade for safe operation. A summary of these criteria is in Appendix B.

Information Requested by EIS Team: The primary objective of conceptual design is to provide engineering design data necessary to support the RA EIS. The DOE's RA EIS subcontractor provided a list of information needed to complete the engineering sections of the draft environmental impact statement (DEIS). The information requested with regard to the alignment included location maps of alternative alignments at scales that would facilitate publication in the DEIS. Meeting these data requests created another condition that bounded the alignment development efforts of NRL conceptual design. The data requests and information provided are described in Nevada Rail Partners' (NRP) *Concordance Table, Caliente Rail Corridor* (NRP 2007b).

Environmental considerations were a priority while developing Rev. 1 of the alignment. The collection of environmental field data (such as biological resources and cultural/historic features) is on-going and concurrent with the conceptual design alignment development. It is anticipated that additional field data inputs will occur, and that the alignment development, as currently documented, may require modification.

2.2 DATA SOURCES

Mapping Data: The Rev. 0 conceptual design was based on public domain mapping data from the USGS. NRP acquired software from TopoDepot that provides a computer interface to generate electronic quadrangle maps that can be utilized in Microstation computer-aided design (CAD) software (discussed in greater detail in Section 3.2). The USGS maps were compiled from two sets of data: year 2003 roads, streams, and other landmarks, and year 2000 (or newer) contour data.

Prior to mapping data for the rail corridor, metric measurements were being utilized as the coordinate system. NRP compiled quad map contours and overlaid them on hill shades provided by Bechtel SAIC Company, LLC (BSC), and determined the proposed USGS mapping could be overlaid on BSC geographic information systems (GIS) drawings without requiring coordinate manipulation.

NRP created electronic quadrangle maps for the corridor in Universal Transfer Mercator (UTM) Zone 11, North American Datum (NAD) 27, English, and BSC provided alignments (in English units) derived using Quantum[®] (further discussed in Section 3.2) which were overlaid, without manipulation, on the

2.0 Basis of Alignment Development

electronic quadrangle maps. In order to allow multiple staff users to work simultaneously on the alignment engineering, individual quadrangle maps were used. This individual map use creates a "seam" between maps. This seam can be removed by tiling all the quadrangle maps; however, this method was not used due to the large electronic file size and inability for multiple users to work with the tiled map.

Average daily traffic (ADT) data for state and federal highways were obtained from the Nevada Department of Transportation.

For Rev. 1, BSC provided mapping data based on 1:20,000-scale aerial photography taken during the spring and summer of 2005. Digital, orthorectified photos, digital terrain models, and topographic maps were generated (in UTM Zone 11, NAD 83, English) as products for use. The change from NAD 27 to NAD 83 was made to comply with project requirements. A large number of planimetric features were captured in the topographic maps (including roads and water features). Other features, such as private lands and jurisdiction, were captured from BSC's GIS database. The digital terrain models were used to generate triangulated irregular network (TIN) models for use in InRoads (discussed in greater detail in Section 3.2) and Quantm[®]. The TIN models were used to refine the alignment using the Quantm[®] route optimization program and further refined by engineers using InRoads.

3.1 PROCESS STEPS

The alignment development process followed a systematic series of steps which first created and then progressively refined feasible, engineered alignments. The starting point of this conceptual design development process was the individual route segments that emerged from the RA EIS scoping process for detailed evaluation and analysis. The series of steps that developed the feasible, engineered alignments include:

- Route Optimization
- Initial Engineered Geometry
- Refined and Adjusted Geometry
- Initial Alignment Drawings to Support Field Investigations
- Define Basis for Analysis¹
- Draft DEIS Drawings

These progressive steps developed the alternative route segments that emerged from scoping, into alignments with engineered geometry for analysis and comparative evaluation. The following paragraphs summarize each of these alignment development steps.

3.2 EXPLANATION OF PROCESS

Route Optimization: As the RA EIS scoping process identified route segments that would be further developed by conceptual design, those routes were subjected to an alignment optimization process. This optimization was conducted with the use of a specialized analysis tool called Quantm[®]. Quantm[®] analyzes a linear route in three dimensions to establish, analyze, and compare a large number (thousands) of alternative three-dimensional (3D) lines through the designated background mapping space. This optimization was an iterative process that repeatedly responded to evolving segment identification over a period of months during the RA EIS scoping timeframe and early conceptual design. This optimization refined the routing of many potential segments, including three specific segment categories.

- Segments of the MK Alignment were optimized with the constraint of remaining within the 0.25-mile-wide CRC. The optimization process was based on the performance criteria listed in the NTRD, and the design criteria in Appendix B. The optimization process incorporated qualitative cost factors that allowed Quantm[®] to compare certain design options (such as a tunnel versus a deep cut) during the course of its optimization analysis, and also considered environmental (natural and human) resources. Input criteria used for the Quantm[®] evaluation are listed in Appendix C.
- The same MK Alignment segments (described in the preceding bullet) were optimized within the 1.0-mile-wide ALW; and were optimized again without any corridor constraint. Additional optimization and corresponding earthwork reduction was achieved.
- As the RA EIS scoping process identified route segments that were either considerable modifications from the MK Alignment or entirely new segments, the optimization process described in the previous two bullets were conducted on these segments.

The Quantm[®]-based optimization steps defined planning-level alignments that represented a starting point for alignment engineering. The Quantm[®] system:

¹ Throughout this and other NRP reports, the phrase "basis for analysis" is used to provide a frame of reference for NRP's evaluations of the alignment's construction engineering and operational characteristics. Except for *Operations and Maintenance Report, Caliente Rail Corridor* (NRP 2007f), NRP reports provide data for all alignment segments so that consideration of other alignment segment combinations may be accomplished.

3.0 Alignment Development Process

- Incorporates technical parameters (into the Quantm[®] modeling software) directly generated by the early conceptual design process
- Provides detailed (3D) information early in the process on segment alignments driven by conceptual design criteria and basis-of-design engineering parameters
- Reviews thousands of alignment variations driven by technical, community, political, or legal requirements
- Considers “what if” scenarios and conducts sensitivity testing either in isolation or in combination for segment(s) based on:
 - Cost of Construction
 - Socioeconomics
 - Rail Geometry
 - Land Impacts
- Considers macro-level environmental features such as:
 - Wilderness Areas
 - Wilderness Study Areas (WSAs)
 - Nevada Test and Training Range (NTTR)
 - Patented Mining Claims
 - Private Lands

Initial Engineered Geometry: Output from the Quantm[®] model was finalized for all segments that were identified in the RA EIS screening process as segments suitable for further analysis. These Quantm[®] alignments were transferred as electronic files from the planning/optimization work team to the alignment engineering work team in order to create the initial, engineered alignment geometry. In this step, the 3-D Quantm[®] lines through space were first converted (as “traced alignments”) into a CAD platform. This CAD platform is Intergraph Microstation (Version 8) along with the alignment-specialty software InRoads (Version 8). Microstation is a civil engineering software package used for creating engineering drawings. InRoads is a software package that computes an alignment’s horizontal and vertical geometry and also computes the cut and fill (earthwork) needed to construct the defined alignment. InRoads computes an alignment’s geometry incorporating topographic information (see Section 2.2 of this report), a designated location, cross section templates, and engineering criteria. The completion of this step resulted in an alignment that was generally similar (and in places, nearly identical) to the optimized Quantm[®] output, but defined by specific geometric parameters such as horizontal curve geometry, tangent segment lengths, and vertical grade percentages.

Refined & Adjusted Geometry: Plots of each initially-engineered InRoads alignment were examined for opportunities to refine the alignments. The effect of these refinements:

- Established alignment geometry that adhered to the NRL Requirements and design criteria. The refinement reduced the potential areas of speed restrictions and thus improved transit time across the alignment segments.
- Improved operational safety, reliability and functionality. The rail alignment was refined
 - to remove geometric conditions such as reverse curves without intermediate tangent segments
 - to reduce track with horizontal curves superimposed on vertical curves
 - to compensate vertical grade where horizontal curves occurred
 - to reduce vertical undulation and the associated roller coaster effect
- Achieved improved constructability. In a few alignments, embankment fills areas were very high, that is over 100 feet above the natural grade. Rather than engineer a bridge at these locations, the conceptual design was adjusted to include embankment fill. This would provide the RA EIS process

3.0 Alignment Development Process

with a design that would represent a bounding case for surface area disturbance, earth moved, and other environmental factors.

- Lowered operational cost. Because frequent curvature, tunnels, and frequent changes in vertical gradient are all features that increase operating costs, the refinements focused on areas where curves and gradients could be flattened, and where tunnels could be avoided.
- Reduced complex geometry. Tangent sections were inserted in some portions of the alignment to reduce the frequency of reverse curves.
- Made more efficient use of existing terrain. The alignment was moved within the CRC to take advantage of slopes and hillsides that would smooth the profile by refining vertical curves. In other segments, the alignment was adjusted to improve the earthwork balance, which improves constructability. Balanced earthwork also reduces permitting issues by eliminating the need to permit borrow sources or waste spoil areas.

Other refinements including adjusting the alignment to shorten bridges, or shifting the alignment to avoid costly engineering works such as tunnels. The consideration of these engineering issues resulted in repeated, iterative refinements of the initial InRoads alignment until it was judged that a feasible alignment (given the current, available data) was developed.

Initial Alignment Drawing to Support Field Investigations: Once a refined and adjusted alignment was identified, plan and profile information were plotted and distributed to the RA EIS team as interim documents. The plots were at a horizontal scale of 1 inch = 2,000 feet. Electronic versions were also provided so that the RA EIS team could reproduce the information at a different scale, depending upon the desired use. These drawings were used by the RA EIS team to guide field investigations and to locate environmental resources such as wetlands, unique habitat, or cultural features.

The current status of the conceptual design, referred to as the "Rev. 1 alignment," presents an alignment that successfully executes the DOE's ROD for the Repository and NOI for the RA EIS. The alignment development process followed these steps:

- Acknowledge any environmental avoidance areas designated by the EIS contractor
- Seek a feasible engineering alignment within the CRC
- Evaluate if impacts (such as total earth moved) can be reduced with an alignment beyond the corridor and within current ALW limits
- Evaluate any remaining high-impact areas within alignments outside the ALW

Following receipt of new aerial mapping and terrain models, Quantm[®] was again used to evaluate the alignment in light of the new topographic data. Output from the Quantm[®] model was then transferred electronically to InRoads to help guide further geometric refinements. The Rev. 1 alignment typically altered the centerline location (compared to Rev. 0) by several hundred feet, and occasionally a greater distance, if impacts could be reduced and alignment's feasibility could be improved.

Environmental considerations were a priority while developing Rev. 1 of the alignment. Water availability is a major issue that simultaneously affects the NRL's engineering design, environmental effects, permitting constraints, and project costs. The principal factor affecting water demand is earthwork – about 90 percent of the water needed for the project would be used to provide for compaction of embankment fill materials, and to control dust during excavation and other earth-moving activities. In Rev. 0, track profile was prepared with the objective of trying to balance earthwork quantities; that is, keeping the total excavation (cut) approximately equal to the placement of embankment (fill). However, the conceptual design approach during Rev. 1 was to adjust the profile so that cut and fill would be reduced. By reducing fill, the water demand for embankment compaction is also reduced.

3.0 Alignment Development Process

regression equations. For structures that would be located in Federal Emergency Management Agency (FEMA) Flood Zone A, the 100-year floodplain, they would be designed to convey 100-year flows with minimal impoundment of water upstream of the structure consistent with FEMA guidelines and county regulations. When the structures are located in areas not studied by FEMA, they would be designed to comply with appropriate county regulations. The design would temporarily impound flows but would minimize potential impacts to flooding and sediment transport at other locations.

Additional environmental factors were also considered in deriving the alignment. This information included the identification of known areas of potential cultural resources impacts. During the process, areas of potential cultural issues were identified; many of these are reflected in the American Indian Resource Document prepared by the American Indian Writers Subgroup in June 2005. The alignment was subsequently adjusted to decrease or eliminate the impacts in these areas.

Information was also provided regarding potential biological avoidance areas near Caliente. The Caliente segment connects the CRC with the Union Pacific Railroad (UPRR) and, ultimately, access to the national rail network. The specific request was to avoid removing trees in this area so that possible impacts to habitat used by an endangered species could be avoided. Construction may have some impacts to this habitat. It is not presently known if any species currently can be found in the area; biological field surveys have not been completed.

There are differences in the engineering stations of the current alignments when compared to those of the original Rev. 0 segments. The differences appear as shifts in the original station locations, station overlaps at the ends of and sometimes within segments, and station gaps. These differences are due to the fragmented nature of the alignments when compared to the submittal schedule, and to the fact that most segments now are longer due to the objective of reducing earthwork quantities.

Several segments considered in the Rev. 0 analysis were eliminated from consideration in the Rev. 1 evaluations. The Crestline alternative for connecting to the UPRR was eliminated; this segment had greater impacts than the two remaining segments (Eccles and Caliente). The Beatty Wash 2 (BW2) segment was eliminated for environmental and operational reasons. By eliminating the BW2 segment, information for Common Segment 7 (CS7) and BW1 were combined with CS6. Other alignment segments that were eliminated include White River 2, Garden Valley 4, and South Reveille 4. These segments were eliminated due to excessive length and/or cost concerns.

Basis for Analysis: The final step in the alignment development process was to compare the alternative segments for the purpose of identifying a continuous alignment that could be used as the basis for analysis alignment for other components of the conceptual design. These components include:

- *Air Quality Emission Factors and Socio-Economic Input, Caliente Rail Corridor* (NRP 2007a)
- *Construction Plan, Caliente Rail Corridor* (NRP 2007d)
- *Comparative Cost Estimates, Caliente Rail Corridor* (NRP 2007c)
- *Operations and Maintenance Report, Caliente Rail Corridor* (NRP 2007f)

Table 3-1 summarizes the engineering factors for comparison of alternative segments.

Table 3-1. Comparison of Alternate Segments

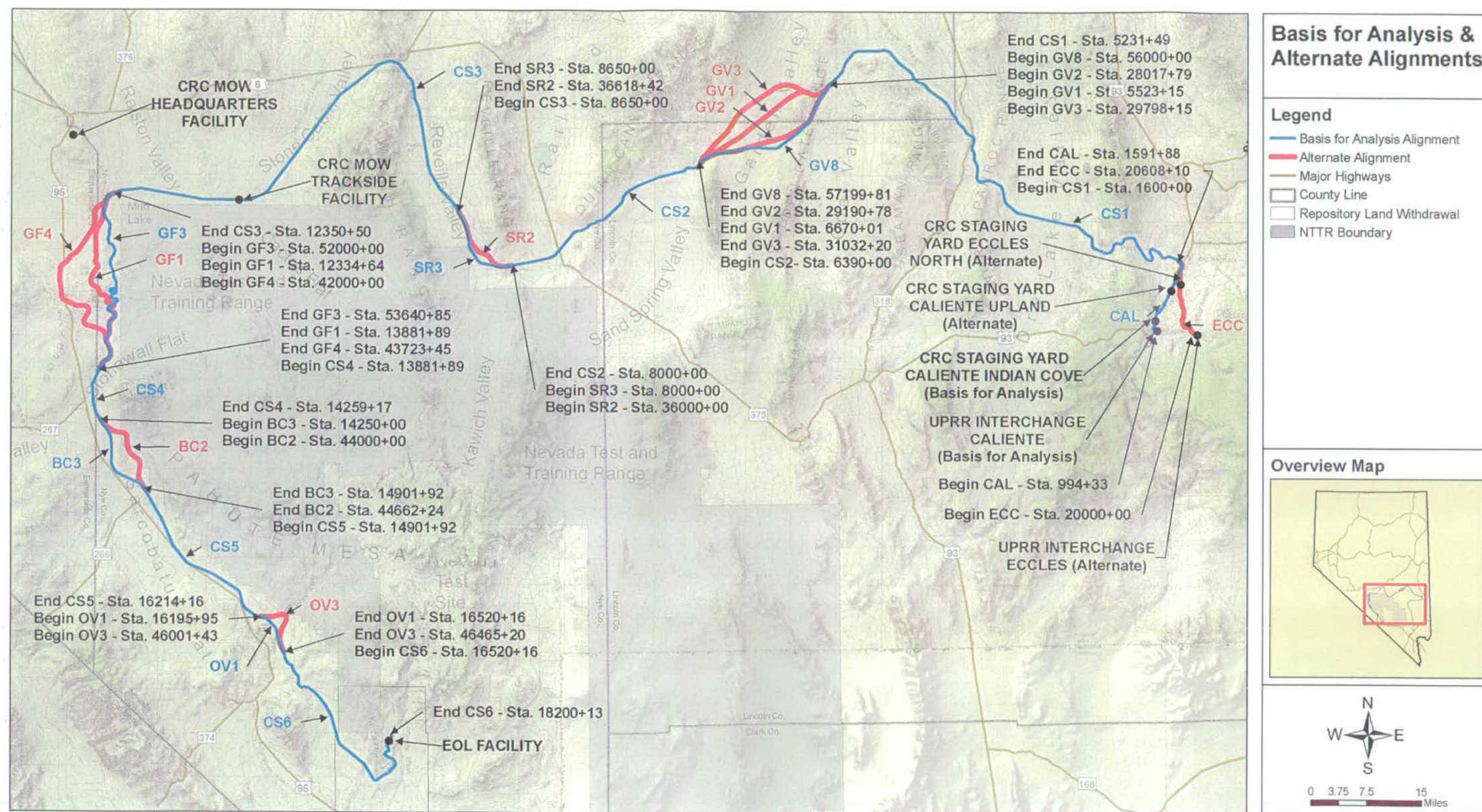
Segment Alternative	Segment Names	
UPRR Interchange	Caliente	Eccles
Engineering	<ul style="list-style-type: none">• Access to yard can be achieved from US 93	<ul style="list-style-type: none">• No possibility of building a wye track, so operational flexibility is limited• Need for large bridge (span greater than

3.0 Alignment Development Process

Table 3-1. Comparison of Alternate Segments

Segment Alternative	Segment Names			
UPRR Interchange	Caliente		Eccles	
Engineering	<ul style="list-style-type: none"> Access to yard can be achieved from US 93 Quarry site on this alignment provides greater flexibility for meeting project ballast needs 		<ul style="list-style-type: none"> No possibility of building a wye track, so operational flexibility is limited Need for large bridge (span greater than 1,000 feet) across Clover Creek at Dutch Flat Four miles of track would encroach into Clover Creek Grade issues at Eccles dictates need for setting hand brakes Nearly twice as expensive as Caliente Earthwork volumes much higher Inability to use Caliente quarry sites would force decision to obtain some ballast from commercial sources 	
Garden Valley (GV)	GV1	GV2	GV3	GV8
Engineering	Generally similar characteristics among all segments			
South Reveille (SR)	SR2		SR3	
Engineering	<ul style="list-style-type: none"> More difficult to construct 		<ul style="list-style-type: none"> Easier to construct, less expensive 	
Goldfield (GF)	GF1	GF3		GF4
Engineering	<ul style="list-style-type: none"> Numerous mining claims, some of which are active Potential for subsidence 	<ul style="list-style-type: none"> Rugged topography at south end of alignment Close to potential quarry site Fewer mining claims than GF1 or GF4 		<ul style="list-style-type: none"> Crosses US 95 twice Very close to town of Goldfield Mining claims increase private property impacts
Bonnie Claire (BC)	BC2		BC3	
Engineering	<ul style="list-style-type: none"> Very rugged terrain, difficult to construct 		<ul style="list-style-type: none"> Less expensive and easier to construct 	
Oasis Valley (OV)	OV1		OV3	
Engineering			<ul style="list-style-type: none"> OV3 result of scoping comment OV3 bridge over Thirsty Canyon OV3 has more earthwork 	

Figure 3-1 shows the continuous alignment that is used as the basis for analysis. Alternate alignment segments are also shown in Figure 3-1.



4.0 Alignment Development Findings

4.1 GENERAL FINDINGS

The conceptual design process has developed feasible geometric alignments that support a credible evaluation and impacts assessment. The products of the alignment development process are this report and the alignment plan and profile drawings. These drawings show:

- Boundary of ALW (not shown for private properties)
- Plan view of horizontal alignment showing
 - Curve locations
 - Bridge locations
 - Siding locations
 - Match lines between sheets
 - Topographic background
 - Major and some minor public roads
 - Profile of alignment showing gradients and vertical curve locations
- Curve data table
- Bridge data table

Requirement and Design Criteria Adherence: Adherence to YMP program requirements, the NTRD, and the design criteria listed in Appendix B is maintained.

Avoidance of Tunnels: The alternative segments have been engineered to avoid tunnels. Tunnels have high capital costs and long tunnels have high operational costs.

Adherence to the CRC and BLM ALW: Figures 4-1 and 4-2, respectively, show the locations where the alignment is outside of the Repository EIS corridor and the BLM ALW Corridor. Figure 4-3 indicates where the proposed construction right-of-way (ROW) would be outside of the ALW.

Wide Variation of Engineering Parameters: The alternative alignment segments define a wide variation of engineering parameters, in terms of length, earthwork, curvature, and transit time. Tables 4-1 and 4-2 provide a summary of the engineering parameters for the total alignment, and the earthwork associated with the alignment used for the basis for analysis.

Construction ROW: The current conceptual design cross sections indicate the area disturbed by construction activities could range in width between 400 and 800 feet (see *Route Sections and Structures, Caliente Rail Corridor* [NRP 2007g]), sheets 2 through 5 and sheet 22). The BLM has articulated a preference for a construction ROW that generally has a common width, end-to-end. No final decisions have been made between DOE and BLM (or other landowners) regarding the amount of ROW or how the ROW boundaries will be configured. The current conceptual design indicates that a nominal 1,000-foot ROW from end-to-end would reasonably allow for the construction and long term operation of the CRC along the majority of the alignment. In specific areas, localized conditions such as grading/drainage, the placement of operational facilities, wells, or construction camps, or the excavation and transportation of ballast may require the designation of additional ROW acreage. In areas with ROW conflicts, wetlands or other sensitive resources and land issues, specified changes to the ROW would be made accordingly. This is the ROW approach currently guiding CRC development pending refinement during further analysis.

ROW requirements for the interchange, staging yard, maintenance-of-way and end-of-line facilities will vary according to the sites' terrain and function. ROW needs for the facilities are presented in the *Facilities Design Analysis Report, Caliente Rail Corridor* (NRP 2007e). For new access roads that are outside of the nominal 1,000-foot ROW, a width of 50 feet would be needed for construction and operation. Locations of these roads, along with the ROW needs for construction camps, quarries, and wells are presented in the *Construction Plan, Caliente Rail Corridor* (NRP 2007d).

4.0 Alignment Development Findings

A small portion of the alignment will fall on non-federal property. In these areas, specified changes to the nominal ROW can be made accordingly. Access to these areas will be negotiated by the DOE.

Operations ROW: ROW requirements for operation of the CRC will be determined by the DOE with input from the BLM.

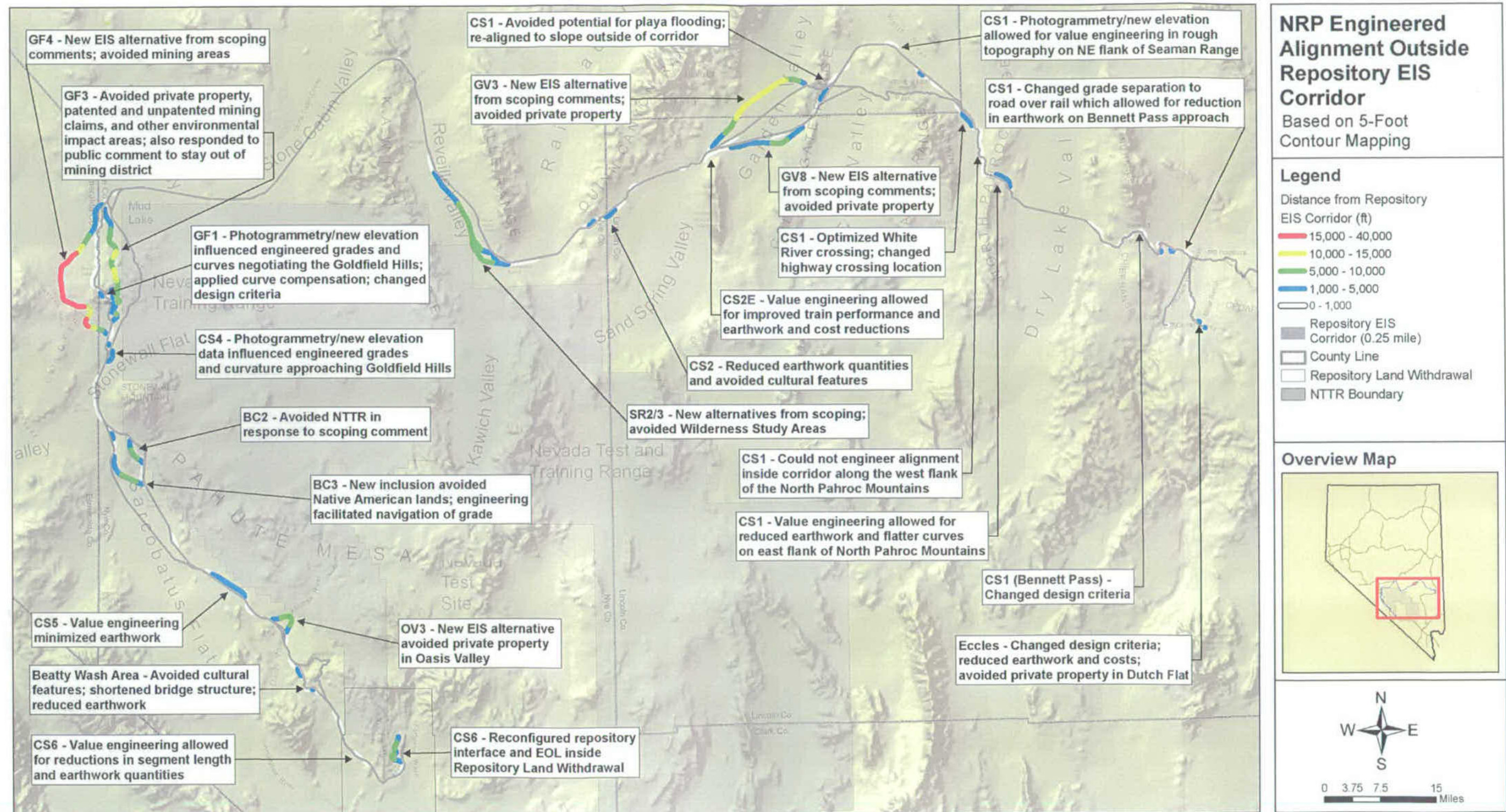
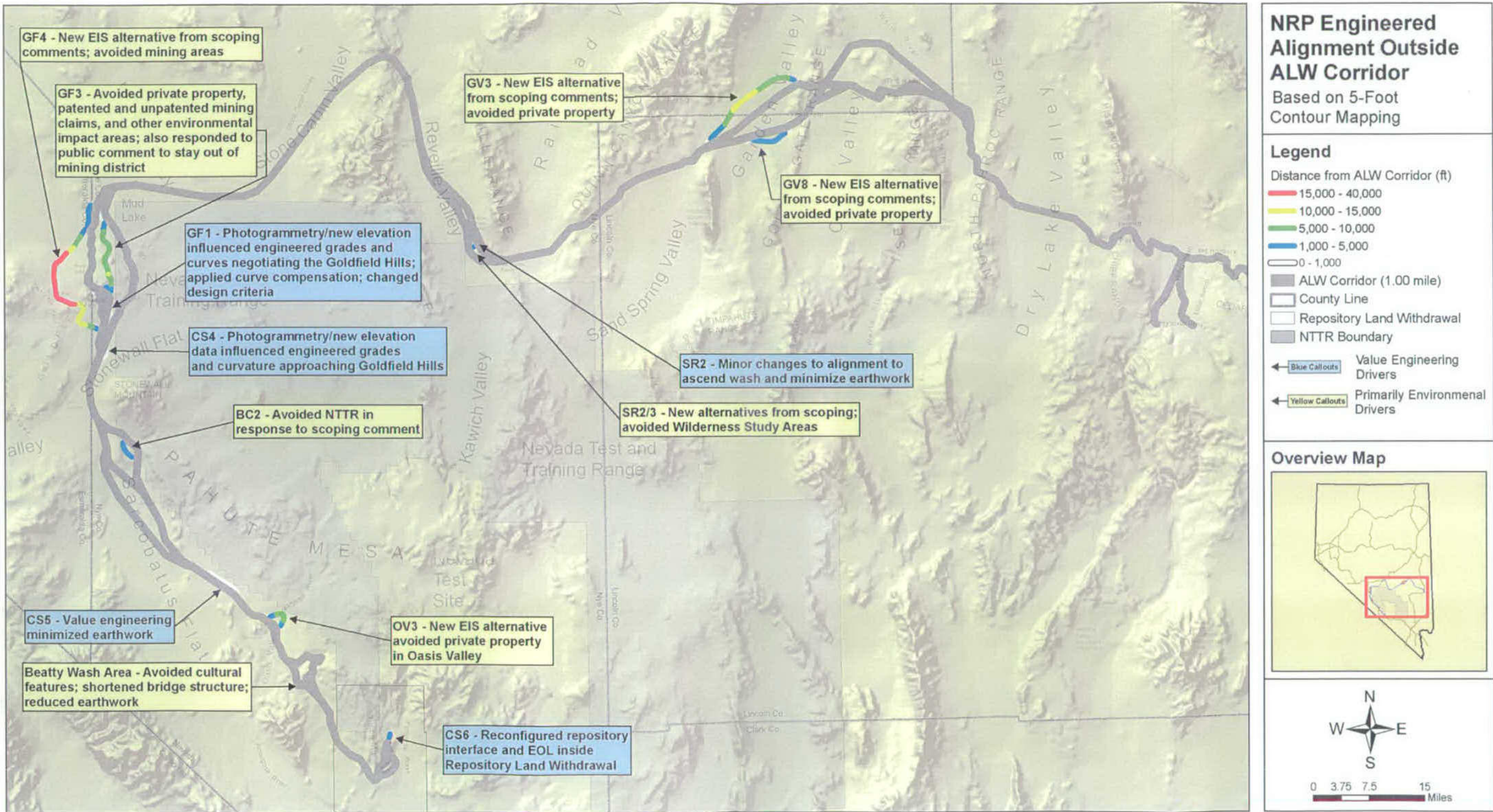


Figure 4-1. NRP Engineered Alignment Outside Repository EIS Corridor



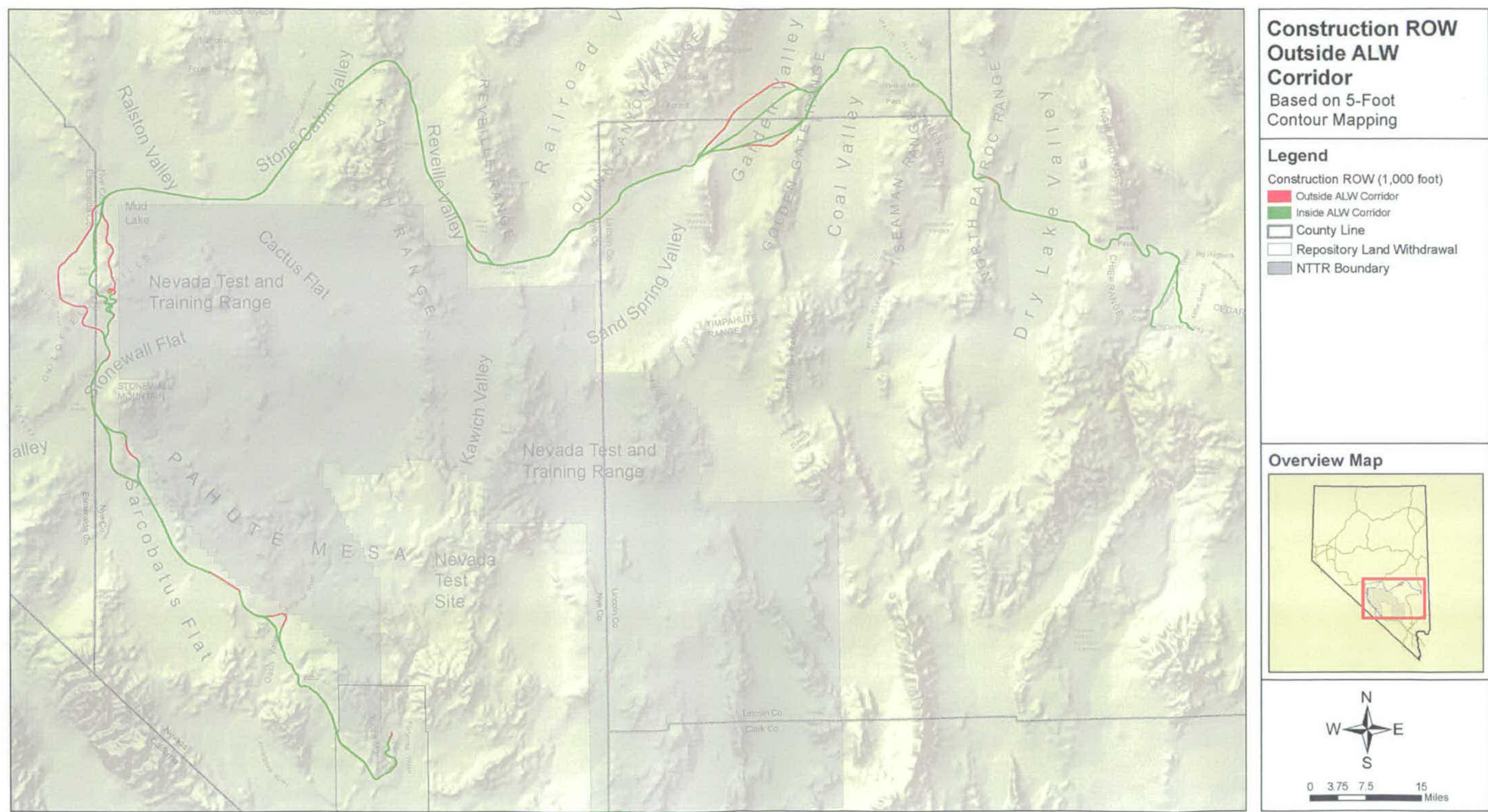


Figure 4-3. Construction ROW Outside ALW Corridor

4.0 Alignment Development Findings

Table 4-1. Summary of Engineering Parameters for the Alignment Used as the CRC Basis for Analysis

Parameter	Value
Length (miles)	331
Maximum Degree of Curve	6° 00' 00"
Length of Curves (feet)	550,858
Length of Curves (miles)	104.33
Length of Curves (% of segment)	31.5
Maximum Engineered Grade (%)	2.00
Maximum Compensated Grade (%)	2.00
Vertical Tangent Length $\geq 1.50\%$ (feet)	439,455
Vertical Tangent Length $\geq 1.50\%$ (miles)	83.23
Vertical Tangent $\geq 1.50\%$ (% of segment)	25.1
Highest Point of Vertical Intersection (PVI) Elevation (feet)	6,290
Lowest PVI Elevation (feet)	3,229
Rise (feet)	7,345
Fall (feet)	8,127
Cut (cubic yards)	30,968,000
Fill (cubic yards)	25,135,000

Table 4-2. Summary of Earthwork for the Alignment Used as the CRC Basis for Analysis

Segment	Length (feet)	Length (miles)	Cut (cubic yards)	Fill (cubic yards)
Caliente	59,755	11.3	634,000	221,000
CS1	372,375	70.5	12,191,000	7,704,000
GV8	119,981	22.7	1,155,000	844,000
CS2	161,762	30.6	1,558,000	680,000
SR3	65,000	12.3	430,000	190,000
CS3	369,440	70.0	3,045,000	2,529,000
GF3	164,085	31.1	3,003,000	5,897,000
CS4	37,728	7.1	304,000	262,000
BC3	65,192	12.3	306,000	921,000
CS5	131,224	24.9	586,000	1,320,000
OV1	32,421	6.1	66,000	715,000
CS6	167,997	31.8	7,690,000	3,852,000
Totals	1,746,960	330.7	30,968,000	25,135,000

4.0 Alignment Development Findings

4.2 SEGMENT-SPECIFIC DATA

Public Roads Crossings and Protection: The alignment segments cross existing public roadways at a number of locations along the CRC. Of these public crossings, five are paved roadway and the remainder cross dirt- or gravel-surfaced roadways. These locations are summarized in Appendix D, Table D-1. Information about the roadway and the proposed method of traffic safety protection is also presented in Table D-1.

The alignment segments also cross private roads and trails as well as legislated corridors for off-road recreational vehicles. These crossings will not be specifically tabulated and crossing designs will not be developed until subsequent phases of development.

Drainage Structures: Because of improved mapping accuracy, the number of drainage structures has increased significantly since Rev. 0. Appendix D lists the structures and includes the estimated station, type of structure (bridge or culvert), number of spans and total length.

Alignment Segment Engineering Parameters: Results of the alignment development process are shown as engineering parameters for each segment, these parameters consist of:

- Length
- Geometric features
- Earthwork

These parameters are defined in Appendix E. Values for each of these parameters are, for the most part, specific and measurable terms that can be used to compare one segment to another. Values for these parameters are tabulated in Appendix E following the definitions. Values are shown for each of the alternative alignment segments, and are listed in geographic order beginning at the Eccles UPRR interchange on the east end of the CRC and follow westerly to the proposed geologic repository operations area and end-of-line facility, which are at the terminus of CS6.

Alignment Narrative Reports: Appendix F provides a series of alignment narrative reports for each of the segments (including common and alternative segments). The purpose of these reports is to provide a better understanding of some of the engineering issues encountered in the conceptual design process. The scope of these reports is limited to engineering issues; they are not intended to provide a comprehensive picture of each and every factor considered in the day-to-day design activities for the various segments.

5.0 References and Applicable Documents

- American Indian Writers Subgroup. 2005. *American Indian Perspectives on the Proposed Rail Alignment Environmental Impact Statement for the U.S. Department of Energy's Yucca Mountain Project*. Las Vegas, NV: Consolidated Group of Tribes and Organizations. Rev. 0, June 2005.
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- _____. 2007c. *Comparative Cost Estimates, Caliente Rail Corridor*. Las Vegas, NV: NRP. Rev. 03, 15 May 2007.
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- _____. 2007e. *Facilities-Design Analysis Report, Caliente Rail Corridor*. Las Vegas, NV: NRP. Rev. 03, 15 May 2007.
- _____. 2007f. *Operations and Maintenance Report, Caliente Rail Corridor*. Las Vegas, NV: NRP. Rev. 03, 15 May 2007.
- _____. 2007g. *Route Sections and Structures-Typical Concepts of Structural Features, Caliente Rail Corridor*. Las Vegas, NV: NRP. Rev. 03, 15 May 2007.

**Appendix A -
NRP Conceptual Design Technical Briefs**

Consideration of Grades in Railroad Design for the NRL

Prepared by NRP – January 2005

T05-00144-O-SYSW-DC-0001-00

Introduction

The following is a brief introduction to the engineering, maintenance, and operational implications of rail line grades (gradients). One of the most important characteristics of rail line design is the grade of the top-of-rail-profile. The grade is expressed as a percentage of the change in vertical elevation over the change in horizontal distance. A 2-foot change in elevation over a 100-foot distance is therefore a 2 percent grade. The capability to pull train loads up such grades - and safely brake downhill - is highly dependent on this grade.

The geometry of constructed rail lines is usually such that the track will have horizontal curves while the track is simultaneously experiencing vertical grades. In other words, the train will be turning left and right while simultaneously going uphill or downhill. This combined movement creates a significant grade-related issue that must be considered; therefore, grade is usually "compensated for curvature." This required compensation is due to the fact that the friction created between the rail and wheels when traversing horizontal curves is significantly higher than on straight-away track.

Industry design guidelines, as articulated in AREMA documents, provide compensation by reducing the grade through a curve by 0.04 percent per degree of curve. For example, on a 2 percent grade around a six degree curve, the grade through the curve would be reduced by 0.24 percent, resulting in a 1.76 percent grade that would actually be constructed. On this 1.76 percent grade through the curve, the train would operate like it was on a uniform 2 percent grade in straight-away track. In rough terrain, this curve compensation can have a considerable impact on the proposed profile and geometric alignment of a heavy freight railroad.

Railroad v. Highway Grades

Due to the physics of the substantial weight of trains rolling on the relatively low friction combination of steel wheels and steel rails, the effects of grade are much more pronounced and critical than for rubber-tired vehicles such as passenger cars, semi-trucks, and buses. Highways and light rail transit lines incorporate grades of 6 percent or more. Even for semi-trucks and buses, grades this steep are formidable and frequently incorporate slow speed "truck lanes" that provide a "compensation" for the steep grade. Light rail transit lines operating lightweight, short passenger cars can utilize brief, steep grades to quickly change elevation in urban areas, but even light rail transit lines do not incorporate long stretches of such steep grade.

Around the turn of the century (1900), numerous rail lines were built with grades of 3 percent and 4 percent or more. These lines were built hurriedly, and frequently were of narrow gauge design in order to be constructed as cheaply and quickly as possible. These lines utilized equipment far smaller and lighter than today's freight rail locomotives and cars. While successful for a time, most of these lines have not survived. The few that remain active are operated as "tourist" railroads for historical and entertainments purposes, and are not considered viable freight transportation.

Engineering Considerations for Railroad Grades

The low friction characteristics of steel wheels on steel rail allow trains to utilize a much lower horsepower-per-ton than other vehicles; therefore, the impacts of even slight grades can be substantial. Minor increases in grades will require a substantial increase in locomotive power to overcome them, especially if it is necessary to maintain a specific speed.

For example, for a typical 3,000 horsepower freight locomotive operating at 25 miles per hour, the tonnage capacity on a 3 percent grade would be less than 30 percent of its capacity on a 1 percent grade. In other words, over three times as many locomotives would be required to maintain speed on a 3 percent grade as compared to a 1 percent grade.

Similarly, the physics of safely controlling trains while descending grades is dramatically affected by increasing grades. The braking capacity available to safely control a descending train is as much a controlling factor as the power required to ascend the same grade.

In consideration of these factors, preferred grades for Class I freight rail design are very limited as compared to highway and light rail transit design. Most U.S. freight railroads, including the UPRR, have adopted preferred criteria of 1 percent grades (curve compensated) on any newly designed main line track. As a practical matter, grades of 2 percent (curve compensated) are the maximum grades that are employed in most mountainous regions of the U.S. There are grades over 2 percent, but these are limited and are problematic for their owners, from both train operations and track maintenance standpoints.

In addition to the considerations above, there are numerous other factors which favor the use of low grades (less than 2 percent curve compensated) in rail design:

Where grades change, long vertical curves are required to gently ease a heavy train from one grade to the next. This approach is necessary to keep forces on couplers and other components within reasonable limits to prevent trains from "breaking in two." The extremely long vertical curves required when transitioning from one very steep grade to the next can greatly reduce any advantage in earthwork or construction that was realized by the steeper grades.

Increasing grades require locomotives to generate greater and greater levels of tractive effort in order to maintain speed. This tractive effort greatly increases forces in trains and track, and results in increased track and equipment maintenance costs. Additionally, high levels of tractive effort at low speeds increase potential for wheel slip, especially in wet and freezing weather. Locomotive wheels slipping under high power can severely, and quickly, damage both rail and wheel.

Locomotive power requirements increase dramatically with increasing grades. This increase results in a highly inefficient operation because trains must be powered with enough locomotives to reasonably transit the steepest grades of the line, which means that they are substantially overpowered for the more moderate lengths of the alignment. A solution is to add and remove locomotives as needed: referred to as "helpers." While this can be done, it is a very costly, time consuming, and inefficient method of operation.

Steeper grades also dramatically increase the likelihood of a runaway car or train and the potential consequences. Should a train become disabled or otherwise be required to stop or switch out disabled equipment, it is a much more hazardous situation on steep grades as compared to moderate grades.

The effects of grades and curves are compounded relative to train resistance and power requirements. These effects are much more pronounced with steeper grades. The increased forces on couplers and cars require extremely cautious train handling techniques and increase the likelihood of derailments and trains breaking in two.

Some of these considerations may not be as serious for the dedicated cask trains; however, due regard must be given to the operation of the various types of "non-cask" trains. The "non-cask" trains likely to operate on the line include construction and ballast trains; supply, oil, and maintenance trains; and trains generated by any "shared use" development that takes place.

A train traversing steeper grades requires more fuel to travel a given distance than a line of moderate grades. The additional power required translates into increased fuel consumption, increased fuel cost, increased locomotive emissions, increased locomotive maintenance costs, and reduced locomotive life.

The steeper grades would likely decrease operating speeds and increase transit times over the line, which would in turn would increase the likelihood that additional train crews and crew facilities would be required.

The operational and maintenance inefficiencies, and costs of steeper grades, are permanent and accrue with every train. By contrast, the construction costs of building moderate grades occur only once and provide operational and maintenance cost benefits for the life of the system. Most older freight rail lines have undergone programs of grade and curve reductions in recent years in order to realize these benefits.

Conclusion

Based on the foregoing summary of the effects of grades on rail operations and maintenance, it can be seen that even moderate increases in grade will have significant (and detrimental) operational, maintenance, safety, and environmental impacts.

Therefore, it is recommended that the NRL adopt gradient criteria in general conformance with that of the U.S. Class I freight rail industry. Generally, that would be preferred grades of no more than 1 percent and maximum grades of no more than 2 percent, with such grades compensated for curvature. This recommendation is consistent with the approach taken to other design criteria aspects and will contribute to a NRL that is safe, reliable, and cost-effective.

**Appendix B -
Proposed NRL Design Criteria Basic Elements**

PROPOSED NRL (YUCCA MOUNTAIN) Design Criteria Basic Elements

Prepared by NRP – June 15, 2005

A design criteria manual for the proposed rail line to Yucca Mountain is currently being developed. The following table is an extract (summary) from the manual of the basic design elements. These design elements were used in the Quantum[®] route selection and optimization analysis.

Table B-1. Summary – NRL Design Criteria

Design Element	Recommend Standard	Comments
Civil Works Design Speed	60 mph (Mainline)	Where practical
Operating Train Speed	Maximum 50 mph (Mainline)	Operating speed governed by curvature and grade
Design Loading	Cooper E-80	Maximum allowable axle load = 34 tons
Track Centers	25 feet sidings and yards	Between track centerlines
ROW	<p>The recommended ROW concept for federal lands is as follows:</p> <ul style="list-style-type: none"> • Adopt a 1,000-foot wide ROW end-to-end centered on the conceptual design alignment centerline, to be used for the construction phase. Exceptions will be in areas containing: <ul style="list-style-type: none"> – railyards – wetlands – private property – county roads – state highways – NTTR – Wilderness Area/WSA – U.S. Forest Service jurisdictions • Generally the ROW will allow for the NRL track and structures including earthwork; for construction-phase activities; for siting of wells and communication towers; and for NRL ancillaries such siding and passing tracks. • Additional ROW boundaries will be designated for extraordinary requirements such as construction camps, perpendicular access roads, rail yards and/or facilities, ballast quarries, and other features that will be implemented outside of the nominal, 1,000-foot ROW. 	
Alignment Width	<ul style="list-style-type: none"> • 200 to 1,000 feet nominal • 100 feet (Single Track) minimum • 130 feet (at sidings) 	Using retaining walls as required

Table B-1. Summary – NRL Design Criteria

Design Element	Recommend Standard	Comments
Turnouts: <ul style="list-style-type: none"> Sidings (Main line) Yards and Back Tracks 	<ul style="list-style-type: none"> No. 20 Power operated No. 11 	<ul style="list-style-type: none"> Eccles may require greater than No. 20 turnouts on UPRR line
Siding Length	<ul style="list-style-type: none"> 10,500 feet minimum clear at Caliente and Eccles 6,000 feet minimum clear elsewhere on the NRL 	<ul style="list-style-type: none"> Accommodate UPRR trains at Caliente Siding spacing 20 to 35 miles
Train Control	Centralized Traffic Control	
Roadbed Sections: <ul style="list-style-type: none"> Roadbed Width (fill) Roadbed Width (cut) Subballast Depth Depth of Ditches 	<ul style="list-style-type: none"> 15 feet-6 inches from centerline, 31 feet total 62 total feet 6 inches minimum Typically 3 feet 	Reference typical Class 1 - North American Railroad standard, main line with concrete ties
Vertical Curves: <ul style="list-style-type: none"> Rate of Change Between Track Gradients (Main Line) 	<ul style="list-style-type: none"> Comply with AREMA speed-based criteria 	<ul style="list-style-type: none"> Will vary for yards, sidings and back tracks
Vertical Grades: <ul style="list-style-type: none"> Maximum (Allowable) 	<ul style="list-style-type: none"> 2.0% (curve compensated) 	<ul style="list-style-type: none"> Mainline grades on curves must be compensated at 0.04% per degree of curve
Horizontal Curves: <ul style="list-style-type: none"> Maximum Degree of Curve Yards and Sidings Minimum Length of Spiral per ½ inch of Superelevation 	<ul style="list-style-type: none"> 6° - 00" (mainline) Radius = 955 feet 10° - 00" (Radius = 574 feet) 30 feet 	
Tangent Lengths (between Horizontal Reverse Curves)	<ul style="list-style-type: none"> 300 feet (Main Line) 150 feet (Yards, Sidings and Back Tracks) 	
Rail	136-lb RE Minimum	Premium rail (head hardened) on curves 2 degrees and greater
Ties	Prestressed concrete	
Superelevation: <ul style="list-style-type: none"> Maximum Maximum Unbalance Superelevation 	<ul style="list-style-type: none"> 4 inches 1 inch 	Based on Class I Railroad standards and maximum operating speed of 50 mph
Clearances for Highway Overpass: <ul style="list-style-type: none"> Vertical Horizontal from Track Centerline to Face of Pier 	<ul style="list-style-type: none"> 24 feet minimum 25 feet minimum 	<ul style="list-style-type: none"> Above top-of-rail

Table B-1. Summary – NRL Design Criteria

Design Element	Recommend Standard	Comments
Lateral Clearance – Mainline (to fixed object)	<ul style="list-style-type: none"> 10 feet minimum (from centerline) 9 feet on thru plate bridges 	Nevada Public Utilities Commission requires 8 - 9.5 feet on curved track
Ballast	2-¾ inch to 1 inch	18 inch shoulders, 3:1 slopes; 12 inch minimum depth below bottom of tie
Crossings: <ul style="list-style-type: none"> State and Federal Highways (Public) All other Public Roads Farm and other roads 	<ul style="list-style-type: none"> Grade Separated Crossing at Grade Passive (Cross-bucks) 	Automatic Crossing protection (warning system) may be warranted on a case by case basis for crossing at-grade public roads Private crossing license
Clearance Envelope	Association of American Railroads Plate F	
Asset Protection		Fully automated on-line
Communications	Train to Wayside, two-way	Fiber-optic communications cable

**Appendix C -
Quantm[®] Input Criteria**

The following are screen shots of parameters values used within the Quantm[®] modeling effort for the CRC. Spatial data included in the model were converted from the YMP-NRL GIS baseline and include such entities as road location, wash location, jurisdictional boundaries, etc. The parameter descriptions that follow apply to the alignments that were derived within Quantm[®] and delivered to NRP for subsequent work in InRoads.

Network File: ybs2n.nwa

	X	Y	Z (ft)	Bearing	Grade %
Start Point	1594301.14	13619153.45	4716.51	344.0	0.00
Finish Point	1614032.43	13768111.00	5210.48	68.0	0.00
Starting guide points 1	1544775.76	13651479.13			
Starting guide points 2	1573147.83	13659790.81			
Finishing guide points 1	1580288.77	13721381.39			
Finishing guide points 2	1554402.87	13738341.12			

Match alignment start/finish

Save

Cancel

Save As...

Limiting Grade: Downhill Uphill

Design %: -2.00 2.00

Sustained %: -2.00 2.00

Over: 20000.0 (ft)

Formation Width (ft): Fill 54.00 Cut 62.10

Minimum Curvature: H curve (ft) 955.00 R-crest (ft) 30000.00 R-sag (ft) 30000.00

K = R/100
R = Radius

Stiffness: Plan 0.85 Profile 0.85

Coordination: Slight distance Eye level Object level

H-LV (ft): 246.06 3.77 0.00

Curve Compensation [%]: 0.0400

☐ Road
☒ Rail

Network Criteria: Criteria reviewed and suggested by Jim Conway of NRP. Some runs had stiffness values approaching one in order to increase the length of tangent between curves in areas of less complex terrain.

Costs File: ymk.cia

Culvert type

New Remove

Cost/ft

Diameter (ft)

Min cover (ft)

Save

Cancel

Save As...

Geological type

Default hardrock

Wall Cost/ft 10000.00 Cost/ft2 10000.00

Viaduct 2911.91

Tunnel 7200.00

Base 200.42

Cost Criteria: Values derived from HeavyBid estimate, except retaining wall costs as no data were available (MK alignment bid did not use retaining walls).

Geological Type File: ybsf.gta

Haul: 0.75 (cost/yard3/mile) Save

Borrow: 3.62 (cost/yard3) Cancel

Dump: 1.38 (cost/yard3) Save As...

Geological type:

Default New

Default Remove

Fill

Rate (cost/yard3) Batter (%)

1.20 50.00

☒ Default

Cut

Strata Stratum ☐ Spoil ☒ Useable

Rate (cost/yard3) Thickness (ft) Batter (%) Bench (ft)

1 1 3.62 3278.00 50.00 10.00

Geological Criteria – Default: Used for areas with alluvium as surficial deposits. Implements geotechnical design criteria.

Geological Type File: ybsf.gta

Haul: 0.75 (cost/yard3/mile) Save

Borrow: 3.62 (cost/yard3) Cancel

Dump: 1.38 (cost/yard3) Save As...

Geological type:

hardrock New

Default Remove

hardrock

☐ Default

Fill

Rate (cost/yard3) Batter (%)

10.00 50.00

Cut

Strata Stratum ☐ Spoil ☒ Useable

Rate (cost/yard3) Thickness (ft) Batter (%) Bench (ft)

1 1 23.83 3278.00 67.00 0.00

Geological Criteria – Hardrock: Used for areas with bedrock at the surface. Implements geotechnical design criteria.

Linear Feature File: yucca_s3.lfa

Linear feature name:

ROADUQ2-US95

Append...

New

Remove

Save

Cancel

Save As...

Nature: Road

Crossing type: Structure

Width (ft) 164.00

Culvert type: No cells

Earth move type: None

Volume: 0 (yard3)

10 15

Crossing clearances:

Relative ☒ > 16.50

Absolute ☐

Centreline ☒ < -16.50

Crossing Criteria – Paved Public Roadways: 16.5 feet minimum clearance either under or over roadway. Values used derived from MK alignment criteria (only data available).

Linear Feature File: yucca_s3.lfa

Linear feature name:

MJSTMUQ2-CONCRETE - 90M

Append...

New

Remove

Save

Cancel

Save As...

Nature: River

Crossing type: Viaduct

Width (ft) 295.27

Culvert type: No cells

Earth move type: None

Volume: 0 (yard3)

15 15

Crossing clearances:

Relative ☒ > 23.00

Absolute ☐

Centreline ☐ <

Crossing Criteria – Washes and Rivers: 23 feet minimum clearance per MK alignment criteria (only data available).

Special Zone File: yuccao_s2b.sza

Special zone name: Federallandacq

Corridor...
Append...
New
Remove
Save
Cancel
Save As...

Nature: Extra Costs
Crossing type:

☒ Global

Rate (cost/acre) 500.00
Margin (ft) 200.00
262 263

Crossing clearances:
☐ Relative ☒ > 0.00
☐ Absolute ☒ < 0.00

Special Zones – Federal Land Costs: Values derived from HeavyBid estimate and assumes a minimum of 200 foot ROW, larger where earthworks require larger footprint.

Special Zone File: yuccao_s2b.sza

Special zone name: Earthworks

Corridor...
Append...
New
Remove
Save
Cancel
Save As...

Nature: Earthwork Limits
Crossing type:

☒ Global

Rate (cost/acre) 0.00
Margin (ft) 0.00
263 263

Crossing clearances:
☐ Relative ☒ > -150.00
☐ Absolute ☒ < 150.00

Special Zones – Earthworks: Set maximum cut and fill to 150 feet in order to let costs drive the decision to require a structure or earthworks in areas of complex terrain.

Special Zones – Other: These zones were included in the Quantm[®] model via GIS data conversion and integration. 400-meter avoidance criteria for springs, violated in several areas in order to facilitate alignments (e.g., GF3, GF4). Avoidance of Forest Service lands, NTTR, state lands, private lands (some violations here as well), Wilderness Areas, WSAs, and tribal lands. Intent is to include additional avoidance criteria derived from the National Environmental Policy Act RA EIS/geotechnical

analysis/hydrological analysis effort and will include things like historic preservation areas, cultural resources, wetlands, soils with engineering restrictions, etc.

**Appendix D -
Engineering Findings**

Table D-1. Summary of CRC Road Crossing Data

Station	Road Name	Road Number	Owner	Surface	ADT (vehicles/day)	Devices	Provides Access To
BASIS FOR ANALYSIS							
1310+00	Beaver Dam Road	none	Lincoln County	Paved	90	Active	Cedar Range
1559+99	US 93	US 93	Federal	Paved	1,305	Separation	Federal Highway Highway over railroad
2130+00	Bennett Springs Road	none	Lincoln County	Dirt/Gravel		Passive	Bennett Pass
2570+00	Black Canyon Road	none	Lincoln County	Dirt/Gravel		Passive	Burnt Springs Range
3050+00	Rattlesnake Road	none	Lincoln County	Dirt/Gravel		Passive	Dry Lake Valley
3827+00	State Route (SR) 318	SR 318	State	Paved	1,005	Separation	State Highway Railroad over highway
4320+00	Timber Mountain Road	none	Nye County	Dirt/Gravel		Passive	Timber Mountain
5050+00	Unnamed	none	Nye County	Dirt/Gravel		Passive	Garden Valley
5290+00	Unnamed	none	Nye County	Dirt/Gravel		Passive	Garden Valley
56305+00	Cherry Creek Road	none	Nye County	Dirt/Gravel		Passive	Garden Valley
56342+00	Garden Valley Road	none	Lincoln County	Dirt/Gravel		Passive	Garden Valley
57035+00	Freiburg Road	none	Lincoln County	Dirt/Gravel		Passive	Garden Valley
57195+00	Shadow Road	none	Lincoln County	Dirt/Gravel		Passive	Garden Valley
6870+00	Quinn Canyon Road	none	Lincoln County	Dirt/Gravel		Passive	Humboldt-Toiyabe National Forest
7400+00	Unnamed	none	Nye County	Dirt/Gravel		Passive	Sand Springs Valley
7670+00	SR 375	SR 375	State	Paved	100	Separation	State Highway Highway over railroad
8000+00	Unnamed	none	Nye County	Dirt/Gravel		Passive	Railroad Valley
8110+00	CR 525	CR 525	Nye County	Dirt/Gravel		Passive	Reveille Valley
8550+00	CR 525/Willow Witch Road	CR 525	Nye County	Dirt/Gravel		Passive	Reveille Valley
9000+00	CR 525	CR 525	Nye County	Dirt/Gravel		Passive	Reveille Valley
9380+00	CR 525	CR 525	Nye County	Dirt/Gravel		Passive	Reveille Valley
10100+00	Unnamed	none	Nye County	Dirt/Gravel		Passive	Clifford Mine
11450+00	CR 665	CR 665	Nye County	Dirt/Gravel		Passive	Stone Cabin Valley
11325+00	AR 504	AR 504	Nye County	Paved		Active	NTTR

Table D-1. Summary of CRC Road Crossing Data

Station	Road Name	Road Number	Owner	Surface	ADT (vehicles/day)	Devices	Provides Access To
15785+00	Unnamed	none	Nye County	Paved		Active	NTTR-Tolicha Peak
16400+00	Unnamed	none	Nye County	Dirt/Gravel		Passive	Colson Pond
ALTERNATE ALIGNMENT SEGMENTS							
Eccles							
20300+00	Beaver Dam Road	none	Lincoln County	Paved	90	Active	Cedar Range
20600+00	US 93	US 93	Federal	Paved	1,305	Separation	Federal Highway Highway over railroad
GV2							
28320+00	Cherry Creek Road	none	Lincoln County	Dirt/Gravel		Passive	Garden Valley
28680+00	Garden Valley Road	none	Lincoln County	Dirt/Gravel		Passive	Garden Valley
29030+00	Freiburg Road	none	Lincoln County	Dirt/Gravel		Passive	Garden Valley
GV3							
30370+00	Cherry Creek Road	none	Nye County	Dirt/Gravel		Passive	Garden Valley
30730+00	Garden Valley Road	none	Lincoln County	Dirt/Gravel		Passive	Garden Valley
30810+00	Cherry Creek West Road	none	Lincoln County	Dirt/Gravel		Passive	Garden Valley
SR2							
36075+00	Reveille Valley Road	none	Nye County	Dirt/Gravel		Passive	Reveille Valley
GF4							
42667+52	US 95	US 95	Federal	Paved	2,000	Separation	Federal Highway Railroad over highway
42970+00	US 95	US 95	Federal	Paved	2,000	Separation	Federal Highway Railroad over highway
OV3							
46190+00	Unnamed	none	Nye County	Dirt/Gravel		Passive	Colson Pond

- Notes: 1) All dirt/gravel road crossing locations are approximate.
 2) All crossing locations correspond to original Blue, Green and Orange Line segment submittals.
 3) Designers will determine ultimate crossing locations (and other appropriate modifications) on a case-by-case basis.

Table D-2. Structures Proposed for the CRC Basis of Analysis Alignment

Segment Name	Station	Number of Spans	Length (feet)	Estimated Total Length (feet)	Type
Caliente	1027+94	3	33 & 120	186	DbI Cell & TPG
	1041+47	6	34	204	Precast Concrete
	1069+09	7	31	217	Precast Concrete
	1169+18	7	30	210	Precast Concrete
	1174+19	7	40	280	Precast Concrete
	1188+87	7	34	238	Precast Concrete
	1237+90	3	25	75	Precast Concrete
	1315+86	6	40	240	Precast Concrete
	1365+45	5	44	220	Precast Concrete
	1432+47	4	32	128	Precast Concrete
	1537+31	16	44	704	Precast Concrete
	1612+80	11	40	440	Precast concrete
	1812+65	3	30	90	Precast concrete
Common Segment 1 - Bennett Pass	1816+93	3	45	135	Precast concrete
	1842+75	3	30	90	Precast concrete
	1880+75	3	33	99	Precast concrete
	1910+35	3	90	270	Multiple box culvert
	1958+40	4	30	120	Precast concrete
	1989+83	3	45	135	Precast concrete
	2000+60	2	85	170	Multiple box culvert
	2147+10	4	45	180	Precast concrete
	2341+40	4	70	280	Precast concrete
	2385+38	8	42	336	Precast concrete
	2442+10	6	70	420	Precast concrete
	2462+80	4	70	280	Precast concrete
	2700+00	2	130	260	Multiple box culvert
	2830+48	5	45	225	Precast concrete
	2915+10	34	30	1020	Precast concrete
	2929+00	20	30	600	Precast concrete
Common Segment 1 - Pahroc Summit	2963+35	5	70	350	Multiple box culvert
	3016+80	7	30	210	Precast concrete
	3024+30	7	30	210	Precast concrete
	3031+80	7	30	210	Precast concrete
	3038+55	7	30	210	Precast concrete
	3140+15	9	30	270	Precast concrete
	3659+44	2	390	780	Multiple box culvert

Table D-2. Structures Proposed for the CRC Basis of Analysis Alignment

Segment Name	Station	Number of Spans	Length (feet)	Estimated Total Length (feet)	Type
	3722+48	4	300	1200	Multiple box culvert
	3762+00	2	350	700	Multiple box culvert
	3813+62	4	420	1680	Multiple box culvert
	3845+80	2	350	700	Multiple box culvert
	3910+70	8	125/45	840	Precast concrete
Common Segment 1 - White River	3911+86	3	160	480	Multiple box culvert
	3961+45	5	30	150	Precast concrete
	4006+30	4	45	180	Precast concrete
	4044+93	5	45	225	Precast concrete
	4105+40	2	110	220	Multiple box culvert
	4108+50	1	125	125	Box culvert
	4120+20	1	90	90	Box culvert
	4163+38	3	45	135	Precast concrete
	4212+10	4	30	120	Precast concrete
	4222+40	1	90	90	Box culvert
	4231+84	2	85	170	Multiple box culvert
	4241+70	1	85	85	Box culvert
	4278+60	3	150	450	Multiple box culvert
	4325+60	4	45	180	Precast concrete
	4344+40	2	80	160	Multiple box culvert
	4393+50	2	180	360	Multiple box culvert
	4429+40	2	80	160	Multiple box culvert
	4485+90	2	80	160	Multiple box culvert
	4490+00	2	115	230	Multiple box culvert
	4510+40	4	30	120	Precast concrete
	4529+00	4	30	120	Precast concrete
	4563+40	4	30	120	Precast concrete
	4646+00	3	33	99	Precast concrete
	4665+95	4	45	180	Precast concrete
	4754+40	2	85	170	Multiple box culvert
	4840+20	2	100	200	Multiple box culvert
	4862+00	2	85	170	Multiple box culvert
	5100+15	11	30	330	Precast concrete
	5177+80	12	30	360	Precast concrete
	5188+60	12	30	360	Precast concrete
	5199+40	12	30	360	Precast concrete

Table D-2. Structures Proposed for the CRC Basis of Analysis Alignment

Segment Name	Station	Number of Spans	Length (feet)	Estimated Total Length (feet)	Type
Garden Valley 8	56027+67	11	33	363	Precast concrete
	56121+66	4	33	132	Precast concrete
	56125+96	4	33	132	Precast concrete
	56216+00	8	45	360	Precast concrete
	56310+28	7	65	455	Precast concrete
	56322+28	7	65	455	Precast concrete
	56333+28	7	65	455	Precast concrete
	56468+60	5	30	150	Precast concrete
	56509+99	6	33	198	Precast concrete
	56533+20	8	30	240	Precast concrete
	56652+36	4	33	132	Precast concrete
	56675+25	10	33	330	Precast concrete
	56684+65	10	33	330	Precast concrete
	56839+35	10	33	330	Precast concrete
	56903+85	18	45	810	Precast concrete
Common Segment 2 - East	6553+15	4	45	180	Precast concrete
	6575+90	4	30	120	Precast concrete
	6652+83	5	45	225	Precast concrete
	6665+30	4	45	180	Precast concrete
	6670+34	1	70	70	Box culvert
	6676+92	1	70	70	Box culvert
	6684+58	1	70	70	Box culvert
	6689+23	1	70	70	Box culvert
	6695+97	1	90	90	Box culvert
	6705+02	1	80	80	Box culvert
	6727+31	1	90	90	Box culvert
	6730+35	3	80	240	Multiple box culvert
	6741+40	1	95	95	Box culvert
	6766+80	2	80	160	Multiple box culvert
	6786+60	7	30	210	Precast concrete
	6829+60	3	80	240	Multiple box culvert
	6864+28	7	45	315	Precast concrete
	6908+70	6	30	180	Precast concrete
	6943+90	8	30	240	Precast concrete
	7008+65	7	30	210	Precast concrete
	7111+63	5	45	225	Precast concrete

Table D-2. Structures Proposed for the CRC Basis of Analysis Alignment

Segment Name	Station	Number of Spans	Length (feet)	Estimated Total Length (feet)	Type
	7120+45	1	80	80	Box culvert
	7124+01	1	80	80	Box culvert
	7126+82	1	80	80	Box culvert
	7133+79	1	80	80	Box culvert
	7176+66	3	33	99	Precast concrete
	7220+49	3	30	90	Precast concrete
	7244+90	4	100	100	Precast concrete
	7454+68	7	45	315	Precast concrete
	7478+85	6	45	270	Precast concrete
	7501+80	4	45	180	Precast concrete
Common Segment 2 - West	7611+00	5	30	150	Precast Concrete
	7638+50	5	40	200	Precast Concrete
	7668+22	4	24	96	Precast Concrete
	7674+92	4	24	96	Precast Concrete
	7707+87	7	24	168	Precast Concrete
	7755+49	3	24	72	Precast Concrete
	7761+11	3	24	72	Precast Concrete
	7818+46	4	40	160	Precast Concrete
	7825+13	7	40	280	Precast Concrete
South Reveille 3	8619+51	5	45	225	Precast Concrete
	8601+26	5	33	165	Precast Concrete
	8597+67	5	33	165	Precast Concrete
	8555+46	3	81	243	Multiple box culvert
	8554+17	3	69	207	Multiple box culvert
	8539+30	3	40	120	Precast Concrete
	8534+48	5	33	165	Precast Concrete
	8527+74	5	33	165	Precast Concrete
	8503+08	3	45	135	Precast Concrete
	8425+82	5	36	180	Precast Concrete
	8420+16	3	30	90	Precast Concrete
	8396+32	5	33	165	Precast Concrete
	8375+67	5	40	200	Precast Concrete
	8284+99	4	118	472	Multiple box culvert
	8254+40	5	40	200	Precast Concrete
	8226+88	7	45	315	Precast Concrete
	8098+13	3	33	99	Precast Concrete

Table D-2. Structures Proposed for the CRC Basis of Analysis Alignment

Segment Name	Station	Number of Spans	Length (feet)	Estimated Total Length (feet)	Type
Common Segment 3 - East	8736+95	3	92	276	Multiple box culvert
	8753+73	5	33	165	Precast Concrete
	8880+50	1	74	74	Box Culvert
	8883+30	5	24	120	Precast Concrete
	8885+00	1	74	74	Box Culvert
	8895+16	3	24	72	Precast Concrete
	8923+26	3	24	72	Precast Concrete
	8939+26	3	74	222	Multiple box culvert
	8961+49	3	74	222	Multiple box culvert
	8973+15	5	30	150	Precast Concrete
	9009+96	5	20	100	Precast Concrete
	9015+78	5	20	100	Precast Concrete
	9032+32	2	84	168	Multiple box culvert
	9036+74	5	20	100	Precast Concrete
	9048+10	3	20	60	Precast Concrete
	9111+15	3	76	228	Multiple box culvert
	9128+40	3	96	288	Multiple box culvert
	9145+75	3	58	174	Multiple box culvert
	9158+06	5	24	120	Precast Concrete
	9163+79	3	88	264	Multiple box culvert
	9224+38	6	40	240	Precast Concrete
	9234+48	7	45	315	Precast Concrete
	9299+60	5	40	200	Precast Concrete
	9341+30	5	24	120	Precast Concrete
	9354+03	5	33	165	Precast Concrete
	9362+00	5	40	200	Precast Concrete
	9435+15	5	30	150	Precast Concrete
	9516+70	5	40	200	Precast Concrete
Common Segment 3 - Warm Springs	9660+53	9	45	405	Precast concrete
	9699+55	5	30	150	Precast concrete
	9763+40	3	33	99	Precast concrete
	9948+33	5	45	225	Precast concrete
	10030+75	5	30	150	Precast concrete
	10049+90	4	30	120	Precast concrete
	10071+60	4	30	120	Precast concrete
	10156+40	6	30	180	Precast concrete

Table D-2. Structures Proposed for the CRC Basis of Analysis Alignment

Segment Name	Station	Number of Spans	Length (feet)	Estimated Total Length (feet)	Type
	10186+39	6	33	198	Precast concrete
	10207+80	3	33	99	Precast concrete
	10108+70	8	30	240	Precast concrete
Common Segment 3 - West 1	10270+45	3	30	90	Precast concrete
	10284+60	5	30	150	Precast concrete
	10290+70	3	80	240	Multiple box culvert
	10476+42	6	33	210	Precast concrete
	10498+05	3	70	210	Multiple box culvert
	10530+33	5	33	165	Precast concrete
	10570+70	2	120	240	Multiple box culvert
	10679+90	11	40	440	Precast concrete
	10696+60	5	30	150	Precast concrete
	10795+00	4	30	120	Precast concrete
	10854+25	5	130	650	Multiple box culvert
	11238+00	20	45	900	Precast concrete
	11416+60	15	30	450	Precast concrete
	10440+90	6	45	270	Precast concrete
	10489+50	3	100	300	Multiple box culvert
	10814+70	6	120	720	Multiple box culvert
Common Segment 3 - West 2	11527+00	10	30	300	Precast Concrete
	11530+48	4	24	96	Precast Concrete
	11535+00	10	30	300	Precast Concrete
	11565+65	10	33	330	Precast Concrete
	11596+85	10	33	330	Precast Concrete
	11617+76	8	30	240	Precast Concrete
	11637+46	5	40	200	Precast Concrete
	12002+70	10	33	330	Precast Concrete
	12011+28	10	33	330	Precast Concrete
	12025+45	10	33	330	Precast Concrete
	12143+24	4	24	96	Precast Concrete
	12158+17	10	40	400	Precast Concrete
	12239+64	5	40	200	Precast Concrete
	12287+91	5	40	200	Precast Concrete
	12313+77	10	30	300	Precast Concrete
	12327+24	10	30	300	Precast Concrete

Table D-2. Structures Proposed for the CRC Basis of Analysis Alignment

Segment Name	Station	Number of Spans	Length (feet)	Estimated Total Length (feet)	Type
Goldfield 3	52001+36	5	33	165	Precast Concrete
	52038+07	3	33	99	Precast Concrete
	52060+00	3	33	99	Precast Concrete
	52121+30	3	20	60	Precast Concrete
	52123+00	3	20	60	Precast Concrete
	52152+48	5	30	150	Precast Concrete
	52222+58	3	153	458	Multiple Box Culvert
	52437+95	6	80	480	Precast Concrete
	52529+09	5	30	150	Precast Concrete
	52934+35	2	132	264	Multiple Box Culvert
	52963+00	2	317	634	Multiple Box Culvert
	52978+78	2	234	468	Multiple Box Culvert
	53045+04	4	296	1184	Multiple Box Culvert
	53091+42	5	36	180	Precast Concrete
	53129+40	5	33	165	Precast Concrete
	53217+29	5	36	180	Precast Concrete
	53322+76	7	36	252	Precast Concrete
	53380+14	7	33	231	Precast Concrete
	53417+45	5	40	200	Precast Concrete
	53452+08	5	40	200	Precast Concrete
	53557+10	8	45	360	Precast Concrete
Common Segment 4	13877+85	7	30	210	Precast concrete
	14093+70	10	40	400	Precast concrete
Bonnie Claire 3	14333+86	7	33	231	Precast Concrete
	14390+02	16	25	400	Precast Concrete
	14404+35	16	25	400	Precast Concrete
	14413+04	20	25	500	Precast Concrete
	14525+83	5	30	150	Precast Concrete
	14775+95	1	104	104	Box Culvert
	14782+79	5	45	225	Precast Concrete
	14798+00	13	40	520	Precast Concrete
	14847+59	6	58	348	Multiple Box Culvert
	14870+23	2	106	212	Multiple Box Culvert
	14873+44	1	102	102	Box Culvert
	14878+52	1	102	102	Box Culvert

Table D-2. Structures Proposed for the CRC Basis of Analysis Alignment

Segment Name	Station	Number of Spans	Length (feet)	Estimated Total Length (feet)	Type
	14909+82	1	76	76	Box Culvert
	14921+39	1	74	74	Box Culvert
	14931+20	1	70	70	Box Culvert
	14934+36	1	74	74	Box Culvert
	14945+21	1	84	84	Box Culvert
	14952+10	1	74	74	Box Culvert
	14966+76	2	62	124	Multiple Box Culvert
	14970+61	2	62	124	Multiple Box Culvert
	14973+56	2	62	124	Multiple Box Culvert
	14995+84	2	78	156	Multiple Box Culvert
	15009+45	2	80	160	Multiple Box Culvert
	15027+64	1	58	58	Box Culvert
	15031+68	1	64	64	Box Culvert
	15036+35	1	60	60	Box Culvert
	15047+79	1	76	76	Box Culvert
	15053+98	1	80	80	Box Culvert
	15063+56	1	86	86	Box Culvert
	15077+91	3	45	135	Precast Concrete
	15088+52	2	82	164	Multiple Box Culvert
	15101+49	1	70	70	Box Culvert
	15113+48	1	70	70	Box Culvert
	15132+30	2	76	152	Multiple Box Culvert
	15154+75	5	40	200	Precast Concrete
Common Segment 5	15218+53	18	33	594	Precast concrete
	15371+70	12	45	540	Precast concrete
	15491+03	9	45	405	Precast concrete
	15540+70	4	25	100	Precast concrete
	15552+34	2	80	160	Multiple box culvert
	15557+02	1	80	80	Box culvert
	15586+45	3	25	75	Precast concrete
	15588+41	3	25	75	Precast concrete
	15592+30	3	25	75	Precast concrete
	15594+89	2	25	50	Precast concrete
	15598+00	2	25	50	Precast concrete
	15642+70	3	25	75	Precast concrete
	15645+65	3	25	75	Precast concrete
	15648+43	4	25	100	Precast concrete

Table D-2. Structures Proposed for the CRC Basis of Analysis Alignment

Segment Name	Station	Number of Spans	Length (feet)	Estimated Total Length (feet)	Type
	15661+63	11	30	330	Precast concrete
	15688+62	2	80	160	Multiple box culvert
	15695+68	1	80	80	Box culvert
	15706+33	2	80	160	Multiple box culvert
	15726+73	9	45	405	Precast concrete
	15761+27	2	80	160	Multiple box culvert
	15765+28	2	80	160	Multiple box culvert
	15768+12	2	80	160	Multiple box culvert
	15778+22	1	80	80	Box culvert
	15781+17	1	80	80	Box culvert
	15871+20	3	80	240	Multiple box culvert
	15883+20	3	80	240	Multiple box culvert
	15897+68	9	45	405	Precast concrete
	15909+68	5	100	500	Multiple box culvert
	15928+21	3	100	300	Multiple box culvert
	15952+65	3	110	330	Multiple box culvert
	15962+30	2	100	200	Multiple box culvert
	15987+75	3	90	270	Multiple box culvert
	16046+92	2	100	200	Multiple box culvert
	16121+58	7	45	315	Precast concrete
	15638+54	3	25	75	Precast concrete
	15717+95	10	45	450	Precast concrete
	15786+10	8	30	240	Precast concrete
	16032+43	2	100	200	Multiple box culvert
Oasis Valley 1	16104+17	7	45	315	Precast Concrete
	16288+06	5	40	200	Precast Concrete
	16326+96	9	40	360	Precast Concrete
	16337+11	1	140	140	Sgl. Box Culvert
	16344+17	1	144	144	Sgl. Box Culvert
	16349+62	19	40	760	Precast Concrete
	16354+51	1	148	148	Sgl. Box Culvert
	16361+69	7	40	280	Precast Concrete
	16396+92	2	94	188	Multiple Box Culvert
	16408+32	3	100	300	Multiple Box Culvert
	16469+27	5	40	200	Precast Concrete
	16481+78	2	106	212	Multiple Box Culvert

Table D-2. Structures Proposed for the CRC Basis of Analysis Alignment

Segment Name	Station	Number of Spans	Length (feet)	Estimated Total Length (feet)	Type
	16519+69	5	106	530	Multiple Box Culvert
Common Segment 6 - Beatty Wash	16568+42	5	40	200	Precast Concrete
	16705+62	9	40, 173	1028	Precast Concrete & DPG
	16885+80	6	40	240	Precast Concrete
	16935+65	5	40	200	Precast Concrete
	16952+35	5	45	225	Precast Concrete
	16998+10	5	40	200	Precast Concrete
	17020+45	5	40	200	Precast Concrete
	17066+70	5	40	200	Precast Concrete
Common Segment 6 - Busted Butte	17139+40	2	84	168	Mult Box Culvert
	17140+98	4	24	96	Precast Concrete
	17158+96	4	33	132	Precast Concrete
	17164+20	4	64	256	Mult Box Culvert
	17281+48	5	33	165	Precast Concrete
	17319+13	5	45	225	Precast Concrete
	17352+30	5	24	120	Precast Concrete
	17355+50	5	20	100	Precast Concrete
	17380+70	5	24	120	Precast Concrete
	17412+33	5	45	225	Precast Concrete
	17461+10	5	24	120	Precast Concrete
	17464+00	5	24	120	Precast Concrete
	17471+20	3	64	192	Mult Box Culvert
	17529+83	5	45	225	Precast Concrete
	17539+20	5	40	200	Precast Concrete
	17629+75	5	30	150	Precast Concrete
	17800+20	5	40	200	Precast Concrete
	17818+80	5	40	200	Precast Concrete
	18052+70	5	234	1170	Mult Box Culvert
	18199+13	5	45	225	Precast Concrete

Table D-3. Structures Proposed for the CRC Alternate Alignments

Segment Name	Station	Number of Spans	Length (feet)	Estimated Total Length (feet)	Type
Eccles	20024+59	5	33 and 45	177	Precast concrete
	20029+39	7	40 and 80	481	Precast concrete
	20090+87	3	242	726	Multiple box culvert
	20093+93	3	248	744	Multiple box culvert
	20095+76	3	250	750	Multiple box culvert
	20155+49	3	25	75	Precast concrete
	20155+50	2	90	180	Multiple box culvert
	20280+36	3	40	120	Precast concrete
	20319+08	3	64	192	Multiple box culvert
	20369+56	3	40	120	Precast concrete
	20379+22	5	40	200	Precast concrete
	20412+20	3	102	306	Multiple box culvert
	20437+66	5	368	1840	Multiple box culvert
	20483+54	3	74	222	Multiple box culvert
	20505+93	1	160	160	Thru-plate girder
	20550+00	11	40	440	Precast concrete
	20607+50	5	40	200	Precast concrete
Garden Valley 1	5871+99	11	38	418	Precast concrete
Garden Valley 2	28046+30	10	40	400	Precast concrete
	28140+00	3	40	120	Precast concrete
	28144+00	3	40	120	Precast concrete
	28236+50	4	102	408	Multiple box culvert
	28335+70	11	40	440	Precast concrete
	28349+70	11	40	440	Precast concrete
	28359+50	11	40	440	Precast concrete
	28462+00	5	30	150	Precast concrete
	28465+10	3	20	60	Precast concrete
	28501+10	3	20	60	Precast concrete
	28532+00	2	72	144	Multiple box culvert
	28535+50	2	72	144	Multiple box culvert
	28542+00	2	90	180	Multiple box culvert
	28559+23	5	45	225	Precast concrete
	28615+53	5	45	225	Precast concrete
	28635+30	8	45	360	Precast concrete
	28730+80	8	45	360	Precast concrete
	28833+95	10	30	300	Precast concrete
	28897+40	20	40	800	Precast concrete
South Reveille 2	36344+43	5	45	225	Precast concrete
	36321+51	5	45	225	Precast concrete
	36291+44	5	30	150	Precast concrete
	36234+03	2	87	174	Multiple box culvert
	36218+76	5	40	200	Precast concrete
	36136+74	7	45	315	Precast concrete

Table D-3. Structures Proposed for the CRC Alternate Alignments

Segment Name	Station	Number of Spans	Length (feet)	Estimated Total Length (feet)	Type
Goldfield 1	13564+10	3	44	132	Precast concrete
	13457+73	5	31	155	Precast concrete
	13280+00	3	272	816	Multiple box culvert
	13245+29	3	226	678	Multiple box culvert
	13173+13	3	34	102	Precast concrete
	13078+23	3	45	135	Precast concrete
	13043+82	5	40	200	Precast concrete
	12944+12	5	30	150	Precast concrete
	13832+22	3	33	99	Precast concrete
	12821+22	3	33	99	Precast concrete
	12777+53	2	82	164	Multiple box culvert
	12710+17	3	40	120	Precast concrete
	12703+26	3	35	105	Precast concrete
	12671+61	5	30	150	Precast concrete
	42012+00	5	40	200	Precast concrete
	42016+40	5	40	200	Precast concrete
	42036+90	7	40	280	Precast concrete
Goldfield 4	42343+16	7	33	231	Precast concrete
	42357+00	3	20	60	Precast concrete
	42387+50	5	28	140	Precast concrete
	42456+50	5	40	200	Precast concrete
	42549+50	5	28	140	Precast concrete
	42630+60	5	80	400	Precast concrete
	42645+20	8	30 and 80	541	Precast concrete
	42872+00	4	196	784	Multiple box culvert
	42923+51	5	30 and 80	301	Precast concrete
	42953+50	4	320	1280	Multiple box culvert
	43087+00	3	80	240	Precast concrete
	43200+51	6	30 and 80	381	Precast concrete
	43273+91	6	31 and 80	381	Precast concrete
	43356+28	7	45	315	Precast concrete
	43397+30	5	28	140	Precast concrete
	43533+37	5	36	180	Precast concrete
	43639+50	10	45	450	Precast concrete
Bonnie Claire 2	44065+60	7	36	252	Precast concrete
	44117+28	2	86	172	Multiple box culvert
	44148+86	2	74	148	Multiple box culvert
	44176+73	3	66	198	Multiple box culvert
	44184+93	3	70	210	Multiple box culvert
	44202+19	2	120	240	Multiple box culvert
	44229+00	5	40	200	Precast concrete
	44256+72	9	40 and 80	640	Precast concrete
	44410+18	2	244	488	Multiple box culvert

Table D-3. Structures Proposed for the CRC Alternate Alignments

Segment Name	Station	Number of Spans	Length (feet)	Estimated Total Length (feet)	Type
	44424+16	13	40 and 45	575	Precast concrete
	44436+18	3	45	135	Precast concrete
	44444+84	7	45	315	Precast concrete
	44457+40	10	40	400	Precast concrete
	44469+63	3	45	135	Precast concrete
	44488+13	3	45	135	Precast concrete
	44587+55	10	35	350	Precast concrete
	44638+18	2	86	172	Multiple box culvert
Oasis Valley 3	46030+52	5	40	200	Precast concrete
	46055+90	1	120	120	Box culvert
	46057+80	1	120	120	Box culvert
	46118+52	2	172	344	Multiple box culvert
	46169+65	4	168	672	Multiple box culvert
	46181+31	7	30 and 80	461	Precast concrete
	46186+79	1	200	200	Box culvert
	46189+80	1	200	200	Box culvert
	46251+05	5	37	185	Precast concrete
	46306+78	2	192	384	Multiple box culvert
	46313+22	5	30 and 80	301	Precast concrete
	46360+48	2	120	240	Multiple box culvert
	46414+15	5	30	150	Precast concrete
	46427+08	2	124	248	Multiple box culvert
Garden Valley 3	29821+95	8	57	456	Multiple box culvert
	30138+66	14	45	630	Precast concrete
	30414+43	1	56	56	Box culvert
	30415+99	3	40	120	Precast concrete
	30418+72	3	33	99	Precast concrete
	30421+05	3	33	99	Precast concrete
	30502+18	5	40	200	Precast concrete
	30632+91	3	33	99	Precast concrete
	30641+47	3	33	99	Precast concrete
	30651+42	3	24	72	Precast concrete
	30666+76	3	24	72	Precast concrete
	30676+71	3	33	99	Precast concrete
	30685+35	8	45	360	Precast concrete
	30728+00	1	24	24	Precast concrete
	30730+30	1	24	24	Precast concrete
	30751+08	7	38	266	Precast concrete
	30766+20	5	28	140	Precast concrete
	30777+54	5	30	150	Precast concrete
	30822+50	3	33	99	Precast concrete
	30877+22	1	58	58	Box culvert
	30880+92	1	60	60	Box culvert

Table D-3. Structures Proposed for the CRC Alternate Alignments

Segment Name	Station	Number of Spans	Length (feet)	Estimated Total Length (feet)	Type
	30891+70	6	40	240	Precast concrete
	30933+44	1	86	86	Box culvert
	30936+75	5	30	150	Precast concrete
	30945+30	1	106	106	Box culvert
	30961+13	1	84	84	Box culvert
	30967+22	1	76	76	Box culvert
	30975+22	3	45	135	Precast concrete

**Appendix E -
Engineering Parameters that Characterize
Alignment Segments**

Table E-1. Definition of Engineering Parameter Terms

Parameter	Definition
Segment Length	
Begin station	Station at beginning of segment. Stationing generally progresses from east to west
End Station	Station at end of segment
Alignment Length (miles)	Total length of segment, in miles
Horizontal Geometry	
Maximum degree of curvature	Sharpest curve within segment
Length of Curves (feet)	Total length of all circular curves within segment (without spiral transition curves)
Length of Curves (miles)	Total length of all circular curves within segment (without spiral transition curves)
Percent of Segment	Percentage of segment length that is within horizontal curves
Vertical Geometry	
Maximum Engineered Grade	Maximum grade (elevation change divided by horizontal length) within segment
Maximum Compensated Grade	Because horizontal curves add rolling resistance to a train (as opposed to tangent track), vertical grades are usually compensated in curves, that is, the grade is reduced by the same amount that the curve adds resistance. Tighter curves add more resistance, and thus the grade is reduced by an appropriate amount. For NRL, grades were compensated by a factor of 0.04% per degree of curvature.
Tangent Length $\geq 1.50\%$ (miles)	Total length of tangent track that is at a grade of 1.5% or greater
Percent of Segment	Percentage of segment length that is within vertical curves
High PVI Elevation	Highest elevation (approximate) of vertical curve PVI along alignment within segment
Low PVI Elevation	Lowest elevation (approximate) of PVI along alignment within segment
Rise (feet)	Total rise in elevation within segment, measured as stationing increases
Fall (feet)	Total fall in elevation within segment, measured as stationing increases
Total rise and fall	Sum of total rise and total fall within a segment
Earthwork	
Cut (cubic yards)	Total amount of material excavated from below natural ground line within segment, rounded to the nearest thousand yards
Alluvial	Amount of alluvial material to be excavated, rounded to nearest thousand yards
Rippable	Amount of rippable rock material to be excavated, rounded to nearest thousand yards
Drill and Blast	Amount of rock to be excavated by drilling and blasting, rounded to nearest thousand yards
Fill (cubic yards)	Total amount of material filled above natural ground line within segment, rounded to the nearest thousand yards

Table E-2. CRC Summary of Engineering Parameters

PARAMETER	Value for CRC Basis for Analysis Alignment
Length (miles)	331
Maximum Degree of Curve	6° 00' 00"
Length of Curves (feet)	550,858
Length of Curves (miles)	104.33
Length of Curves (% of segment)	31.5%
Maximum Engineered Grade (%)	2.00%
Maximum Compensated Grade (%)	2.00%
Vertical Tangent Length $\geq 1.50\%$ (feet)	439,455
Vertical Tangent Length $\geq 1.50\%$ (miles)	83.23
Vertical Tangent $\geq 1.50\%$ (% of segment)	25.1%
Highest PVI Elevation (feet)	6290
Lowest PVI Elevation (feet)	3229
Rise (feet)	7,345
Fall (feet)	8,127
Rise and Fall Total (feet)	15,472
Cut (cubic yards)	30,968,000
Alluvial	22,094,000
Rippable	2,074,000
Drill / Blast	6,800,000
Fill (cubic yards)	25,135,000

Table E-3. Engineering Parameters for the Caliente and Eccles Segments

PARAMETER	SEGMENT NAME	
	Caliente	Eccles
Beginning Stations	994+33	20000+00
Ending Stations	1591+88	20608+10
Length (miles)	11.32	11.50
Maximum Degree of Curve	4^ 00' 00"	6^ 00' 00"
Length of Curves (feet)	12,580	21,320
Length of Curves (miles)	2.38	4.04
Length of Curves (% of segment)	20.73%	35.06%
Maximum Engineered Grade (%)	1.69%	1.88%
Maximum Compensated Grade (%)	1.69%	2.00%
Vertical Tangent Length \geq 1.50% (feet)	320	22,347
Vertical Tangent Length \geq 1.50% (miles)	0.06	4.23
Vertical Tangent \geq 1.50% (% of segment)	0.53%	36.75%
Highest PVI Elevation (feet)	4697	4895
Lowest PVI Elevation (feet)	4412	4615
Rise (feet)	285	343
Fall (feet)	0	290
Rise and Fall Total (feet)	285	633
Cut (cubic yards)	634,000	2,394,000
Alluvial	545,367	1,020,374
Rippable	89,109	887,447
Drill / Blast	0	486,358
Fill (cubic yards)	221,000	1,330,000

Table E-4. Engineering Parameters for CS1

PARAMETER	SEGMENT NAME			
	CS1 - Totals	CS1-Bennett	CS1-Pahroc	CS1-WR1
Beginning Stations	1600+00	-	-	-
Ending Stations	5231+49	-	-	-
Length (miles)	70.53	25.57	18.61	26.34
Maximum Degree of Curve	4^ 00' 00"	4^ 00' 00"	2^ 30' 00"	2^ 00' 00"
Length of Curves (feet)	138,930	51,760	37,593	49,577
Length of Curves (miles)	26.31	9.80	7.12	9.39
Length of Curves (% of segment)	37.3%	38.3%	38.3%	35.7%
Maximum Engineered Grade (%)	1.93%	1.88%	1.93%	1.90%
Maximum Compensated Grade (%)	2.00%	2.00%	2.00%	1.98%
Vertical Tangent Length $\geq 1.50\%$ (feet)	180,715	119,343	46,377	14,995
Vertical Tangent Length $\geq 1.50\%$ (miles)	34.22	22.60	8.78	2.84
Vertical Tangent $\geq 1.50\%$ (% of segment)	48.5%	88.4%	47.2%	10.8%
Highest PVI Elevation (feet)	5752	5752	5434	5376
Lowest PVI Elevation (feet)	4609	4609	4609	4948
Rise (feet)	2,320	1,055	825	440
Fall (feet)	1,990	1,143	486	361
Rise and Fall Total (feet)	4,310	2,198	1,311	801
Cut (cubic yards)	12,192,000	5,070,000	5,529,000	1,593,000
Alluvial	10,022,000	4,023,451	4,405,683	1,592,522
Rippable	42,000	42,372	0	0
Drill / Blast	2,127,000	1,003,756	1,123,233	0
Fill (cubic yards)	7,704,000	2,554,000	4,000,000	1,150,000

Table E-5. Engineering Parameters for GV1, GV2, GV3, and GV8

PARAMETER	SEGMENT NAME			
	GV1	GV2	GV3	GV8
Beginning Stations	5523+15	28017+79	29798+15	56000+00
Ending Stations	6670+01	29190+78	31032+20	57199+81
Length (miles)	21.72	22.22	23.37	22.72
Maximum Degree of Curve	1^ 30' 00"	1^ 15' 00"	2^ 30' 00"	1^ 15' 00"
Length of Curves (feet)	21,800	16,409	48,018	22,441
Length of Curves (miles)	4.13	3.11	9.09	4.25
Length of Curves (% of segment)	19.0%	14.0%	38.9%	18.70%
Maximum Engineered Grade (%)	1.88%	1.82%	1.88%	1.68%
Maximum Compensated Grade (%)	1.93%	1.86%	1.94%	1.73%
Vertical Tangent Length $\geq 1.50\%$ (feet)	24,491	8,004	21,555	12,437
Vertical Tangent Length $\geq 1.50\%$ (miles)	4.64	1.52	4.08	2.36
Vertical Tangent $\geq 1.50\%$ (% of segment)	21.4%	6.8%	17.5%	10.37%
Highest PVI Elevation (feet)	5850	5850	5850	5850
Lowest PVI Elevation (feet)	5010	5012	5010	5012
Rise (feet)	1,009	842	988	908
Fall (feet)	187	19	165	85
Rise and Fall Total (feet)	1,196	860	1,153	993
Cut (cubic yards)	355,000	939,000	654,000	1,154,550
Alluvial	298,472	938,698	653,890	1,064,666
Rippable	0	0	0	38,922
Drill / Blast	56,911	0	0	50,962
Fill (cubic yards)	1,077,000	694,000	689,000	844,032

Table E-6. Engineering Parameters for CS2

PARAMETER	SEGMENT NAME		
	CS2-Totals	CS2-East 1-2-3	CS2-West
Beginning Stations	6390+00	-	-
Ending Stations	8000+00	-	-
Length (miles)	30.64	23.06	7.58
Maximum Degree of Curve	2^ 45' 00"	2^ 45' 00"	0^ 40' 00"
Length of Curves (feet)	40,557	34,602	5,955
Length of Curves (miles)	7.68	6.55	1.13
Length of Curves (% of segment)	25.19%	28.42%	14.89%
Maximum Engineered Grade (%)	1.86%	1.86%	1.09%
Maximum Compensated Grade (%)	1.94%	1.94%	1.09%
Vertical Tangent Length $\geq 1.50\%$ (feet)	32,873	32,873	0
Vertical Tangent Length $\geq 1.50\%$ (miles)	6.23	6.23	0
Vertical Tangent $\geq 1.50\%$ (% of segment)	20.42%	27.00%	0.00%
Highest PVI Elevation (feet)	5881	5881	5578
Lowest PVI Elevation (feet)	5355	5435	5355
Rise (feet)	565	342	223
Fall (feet)	836	756	80
Rise and Fall Total (feet)	1,401	1,098	303
Cut (cubic yards)	1,558,000	1,459,406	98,445
Alluvial	1,158,000	1,059,199	98,445
Rippable	0		
Drill / Blast	400,000	400,208	
Fill (cubic yards)	680,000	588,793	91,337

Table E-7. Engineering Parameters for SR2 and SR3

PARAMETER	SEGMENT NAME	
	SR2	SR3
Beginning Station	36000+00	8000+00
Ending Station	36618+42	8650+00
Length (miles)	11.71	12.31
Maximum Degree of Curve	2^ 00' 00"	1^ 45' 00"
Length of Curves (feet)	26,897	21,453
Length of Curves (miles)	5.09	4.06
Length of Curves (% of segment)	43.49%	33.01%
Maximum Engineered Grade (%)	1.77%	1.82%
Maximum Compensated Grade (%)	1.84%	1.89%
Vertical Tangent Length \geq 1.50% (feet)	9,930	9,010
Vertical Tangent Length \geq 1.50% (miles)	1.88	1.71
Vertical Tangent \geq 1.50% (% of segment)	16.06%	13.86%
Highest PVI Elevation (feet)	6129	6129
Lowest PVI Elevation (feet)	5578	5578
Rise (feet)	441	589
Fall (feet)	51	37
Rise and Fall Total (feet)	492	626
Cut (cubic yards)	661,000	430,000
Alluvial	266,575	219,181
Rippable	0	0
Drill / Blast	394,397	211,001
Fill (cubic yards)	287,000	190,000

Table E-8. Engineering Parameters for CS3

PARAMETER	SEGMENT NAME				
	CS3-Totals	CS3-East	CS3-Warm Springs	CS3-West 1	CS3-West 2
Beginning Station	8650+00	8650+00	9635+00	10236+25	11400+00
Ending Station	12350+50	9628+91	10236+25	11400+00	12350+50
Length (miles)	70.0	18.5	11.4	22.4	18.0
Maximum Degree of Curve	1^ 00' 00"	1^ 00' 00"	1^ 00' 00"	0^ 20' 00"	0^ 30' 00"
Length of Curves (feet)	76,814	19,677	25,169	20,796	11,172
Length of Curves (miles)	14.55	3.73	4.77	3.94	2.12
Length of Curves (% of segment)	20.80%	20.10%	41.86%	17.87%	
Maximum Engineered Grade (%)	1.98%	1.98%	1.96%	1.42%	0.78%
Maximum Compensated Grade (%)	2.00%	2.00%	1.96%	0.90%	0.31%
Vertical Tangent Length $\geq 1.50\%$ (feet)	37,400	700	36,700	0	0
Vertical Tangent Length $\geq 1.50\%$ (miles)	7.08	0.13	6.95	0	0
Vertical Tangent $\geq 1.50\%$ (% of segment)	10.13%	0.72%	61.04%	0.00%	0.00%
Highest PVI Elevation (feet)	6290	6,196	6,290	5,937	5,359
Lowest PVI Elevation (feet)	5209	5,707	5,760	5,359	5,209
Rise (feet)	734	168	530	12	24
Fall (feet)	1,641	537	355	590	159
Rise and Fall Total (feet)	2,375	705	885	602	183
Cut (cubic yards)	3,046,000	1,100,083	1,361,726	368,313	215,900
Alluvial	2,470,000	1,100,083	813,520	340,719	215,900
Rippable	520,000		492,751	27,593	
Drill / Blast	55,000		55,455		
Fill (cubic yards)	2,529,000	533,193	1,447,924	333,353	214,570

Table E-9. Engineering Parameters for GF1, GF3, and GF4

PARAMETER	SEGMENT NAME		
	GF1	GF3	GF4
Beginning Station	12334+64	52000+00	42000+00
Ending Station	13881+89	53640+85	43723+45
Length (miles)	29.30	31.08	32.64
Maximum Degree of Curve	5° 30' 00"	6° 00' 00"	1° 50' 00"
Length of Curves (feet)	76,033	94,915	79,651
Length of Curves (miles)	14.40	17.98	15.09
Length of Curves (% of segment)	49.14%	57.85%	46.22%
Maximum Engineered Grade (%)	1.90%	1.94%	1.95%
Maximum Compensated Grade (%)	2.00%	2.00%	2.00%
Vertical Tangent Length $\geq 1.50\%$ (feet)	82,929	83,335	68,805
Vertical Tangent Length $\geq 1.50\%$ (miles)	15.71	15.78	13.03
Vertical Tangent $\geq 1.50\%$ (% of segment)	53.60%	50.79%	39.92%
Highest PVI Elevation (feet)	5926	6086	5893
Lowest PVI Elevation (feet)	4753	4753	4753
Rise (feet)	771	862	874
Fall (feet)	1,242	1,333	1,345
Rise and Fall Total (feet)	2,013	2,195	2,219
Cut (cubic yards)	4,006,000	3,003,000	2,449,000
Alluvial	562,686	277,195	566,921
Rippable	1,168,417	432,696	199,936
Drill / Blast	2,274,931	2,292,632	1,682,128
Fill (cubic yards)	2,537,000	5,897,000	4,361,000

Table E-10. Engineering Parameters for CS4

PARAMETER	SEGMENT NAME
	CS4
Beginning Station	13881+89
Ending Station	14259+17
Length (miles)	7.15
Maximum Degree of Curve	1^ 00' 00"
Length of Curves (feet)	5,926
Length of Curves (miles)	1.12
Length of Curves (% of segment)	15.63%
Maximum Engineered Grade (%)	1.00%
Maximum Compensated Grade (%)	0.41%
Vertical Tangent Length $\geq 1.50\%$ (feet)	0
Vertical Tangent Length $\geq 1.50\%$ (miles)	0.00
Vertical Tangent $\geq 1.50\%$ (% of segment)	0.00%
Highest PVI Elevation (feet)	4755
Lowest PVI Elevation (feet)	4695
Rise (feet)	0
Fall (feet)	60
Rise and Fall Total (feet)	60
Cut (cubic yards)	304,000
Alluvial	304,218
Rippable	0
Drill / Blast	0
Fill (cubic yards)	262,000

Table E-11. Engineering Parameters for BC2 and BC3

PARAMETER	SEGMENT NAME	
	BC2	BC3
Beginning Station	44000+00	14250+00
Ending Station	44662+24	14901+92
Length (miles)	12.54	12.35
Maximum Degree of Curve	1^ 30' 00"	1^ 00' 00"
Length of Curves (feet)	34,113	26,879
Length of Curves (miles)	6.46	5.09
Length of Curves (% of segment)	51.51%	41.23%
Maximum Engineered Grade (%)	1.50%	1.70%
Maximum Compensated Grade (%)	1.56%	1.72%
Vertical Tangent Length \geq 1.50% (feet)	20,165	14,710
Vertical Tangent Length \geq 1.50% (miles)	3.82	2.79
Vertical Tangent \geq 1.50% (% of segment)	30.45%	22.56%
Highest PVI Elevation (feet)	4695	4695
Lowest PVI Elevation (feet)	4160	4160
Rise (feet)	0	17
Fall (feet)	535	552
Rise and Fall Total (feet)	535	569
Cut (cubic yards)	598,000	306,000
Alluvial	29,773	166,867
Rippable		56,834
Drill / Blast	568,378	81,906
Fill (cubic yards)	1,235,000	921,000

Table E-12. Engineering Parameters for CS5

PARAMETER	SEGMENT NAME
	CS5
Beginning Station	14901+92
Ending Station	16214+16
Length (miles)	24.85
Maximum Degree of Curve	1^ 00' 00"
Length of Curves (feet)	20,361
Length of Curves (miles)	3.86
Length of Curves (% of segment)	15.52%
Maximum Engineered Grade (%)	1.50%
Maximum Compensated Grade (%)	1.50%
Vertical Tangent Length $\geq 1.50\%$ (feet)	4,900
Vertical Tangent Length $\geq 1.50\%$ (miles)	0.93
Vertical Tangent $\geq 1.50\%$ (% of segment)	3.73%
Highest PVI Elevation (feet)	4170
Lowest PVI Elevation (feet)	4006
Rise (feet)	227
Fall (feet)	335
Rise and Fall Total (feet)	562
Cut (cubic yards)	586,000
Alluvial	303,596
Rippable	282,453
Drill / Blast	0
Fill (cubic yards)	1,320,000

Table E-13. Engineering Parameters for OV1 and OV3

PARAMETER	SEGMENT NAME	
	OV1	OV3
Beginning Station	16195+95	46001+43
Ending Station	16520+16	46465+20
Length (miles)	6.14	8.78
Maximum Degree of Curve	1^ 00' 00"	2^ 00' 00"
Length of Curves (feet)	12,027	24,628
Length of Curves (miles)	2.28	4.66
Length of Curves (% of segment)	37.10%	53.10%
Maximum Engineered Grade (%)	1.40%	1.40%
Maximum Compensated Grade (%)	1.44%	1.43%
Vertical Tangent Length $\geq 1.50\%$ (feet)	0	0
Vertical Tangent Length $\geq 1.50\%$ (miles)	0.00	0.00
Vertical Tangent $\geq 1.50\%$ (% of segment)	0.00%	0.00%
Highest PVI Elevation (feet)	4053	4053
Lowest PVI Elevation (feet)	3896	3935
Rise (feet)	74	66
Fall (feet)	157	149
Rise and Fall Total (feet)	231	215
Cut (cubic yards)	66,000	156,000
Alluvial	57,667	155,932
Rippable	8,466	0
Drill / Blast		
Fill (cubic yards)	715,000	1,339,000

Table E-14. Engineering Parameters for CS6

PARAMETER	SEGMENT NAME		
	CS6-Totals	BW1	CS6-Busted Butte
Beginning Station	16520+16	-	-
Ending Station	18200+13	-	-
Length (miles)	31.82	11.13	20.68
Maximum Degree of Curve		5^ 00' 00"	6^ 00' 00"
Length of Curves (feet)	43,658	15,482	28,176
Length of Curves (miles)	8.27	2.93	5.34
Length of Curves (% of segment)	26.0%	26.34%	25.80%
Maximum Engineered Grade (%)	2.00%	2.00%	2.00%
Maximum Compensated Grade (%)	1.83%	1.83%	1.76%
Vertical Tangent Length $\geq 1.50\%$ (feet)	32,610	12,210	20,400
Vertical Tangent Length $\geq 1.50\%$ (miles)	6.18	2.31	3.86
Vertical Tangent $\geq 1.50\%$ (% of segment)	19.4%	20.77%	18.68%
Highest PVI Elevation (feet)	4115	4115	3673
Lowest PVI Elevation (feet)	3229	3751	3229
Rise (feet)	626	182	444
Fall (feet)	731	391	340
Rise and Fall Total (feet)	1,357	573	784
Cut (cubic yards)	7,690,000	2,067,000	5,623,000
Alluvial	5,505,000	629,800	4,875,000
Rippable	604,000	10,646	592,995
Drill / Blast	1,581,000	1,426,233	154,865
Fill (cubic yards)	3,852,000	1,177,463	2,674,078

**Appendix F -
Alignment Narrative Reports**

CALIENTE SEGMENT**Basis for Analysis**
Length: 11.32 miles

The procedures, issues, and problems related to the design of this segment are as follows:

Quantm[®] Alignment Replication: The alignment follows the Quantm[®] output as it retraces the former UPRR roadbed (now abandoned), except where the new alignment deviates at the north end to begin the approach up to Bennett Pass. A third leg (southwest) was added to the UPRR wye in Caliente, an interchange yard was added at Indian Cove north of town, and an interchange siding was added for pick-up and set-out along the UPRR mainline.

Tie-in Points: The tie-in was adjusted to eliminate the Caliente-Eccles connector segment and to end the Caliente and Eccles segments at the same location.

Major Engineering Issues: In future design efforts, there is a need for a track template with minimum impact on adjacent wetlands and other environmental features. Significant lengths of retaining walls may be required.

Major Structures: The bridges previously in place on the UPRR line over Clover Creek and Meadow Valley Wash were replaced, and a new bridge and grade separation were added at US 93.

Cut/Fill Quantities and Balancing: Overall cut quantities are high. The potential exists for better balancing (if desirable) during future design stages.

Position Within the 1.0-mile BLM ALW Corridor (if applicable): The alignment was centered within the BLM ALW corridor.

Other Boundary and/or Environmental Constraints: The alignment passes through numerous private properties along Meadow Valley Wash while keeping to the route of the abandoned UPRR line.

Known Utility Issues: High-voltage power lines run parallel to this segment for much of the length; the impact from potential underground utilities is unknown.

Drainage Issues: The alignment is flat and may be subject to flooding from Clover Creek and/or Meadow Valley Wash. More detailed hydraulic data are forthcoming through related work. Potential wetland issues along several parts of the alignment may call for narrow typical section design.

The following is a general description of the types of construction that could be utilized in developing a railroad line in a wetlands area, at an elevation typically 3 feet to 10 feet above existing ground. It is assumed that the entire configuration would be higher than surrounding existing ground (i.e., no cut sections would be required). It is also assumed that final design would incorporate the appropriate railroad profile, drainage and other features in conformance with project requirements and criteria. Refer to the typical cross-section drawings (Figures F-1, F-2, and F-3) for further details.

- Standard Embankment: The cross section of this method consists of the earthwork fill section incorporating nominally 2:1 side slopes (Figure F-1). The total width of this embankment varies according to how much the proposed track profile is above the existing ground elevation. This method of construction would cost approximately \$300/foot. This is the least costly and least complex method of construction, and is typical of most railroad construction, especially in open areas.
- Retained Fill: The cross-section of this method consists of the trackway contained within two vertical retaining walls set a uniform distance apart (Figure F-2). The retaining walls can consist of sheet piling, mechanically stabilized earth, or conventional cast-in-place concrete construction. The width of the overall cross-section remains uniform and the height of the walls vary as required. Similarly, in

cut sections, retaining walls would hold the existing ground back as the trackway was constructed below the existing ground elevation. Retaining walls would cost approximately \$3,000/foot.

- Continuous Bridge:** The cross-section of this method consists of the trackway constructed on a low continuous bridge (Figure F-3). This bridge would be of similar design to typical precast concrete railroad bridges. The bridge would be supported on steel H piles driven into the existing ground at appropriate intervals. A continuous bridge would cost approximately \$6,000/foot. This method would only be used where higher fills (e.g., greater than approximately 6 feet) would be required. Otherwise, the bridge would be effectively constructed "on the ground," defeating the purpose of having a bridge. The retained fill method would be used in sections with lower fill requirements.

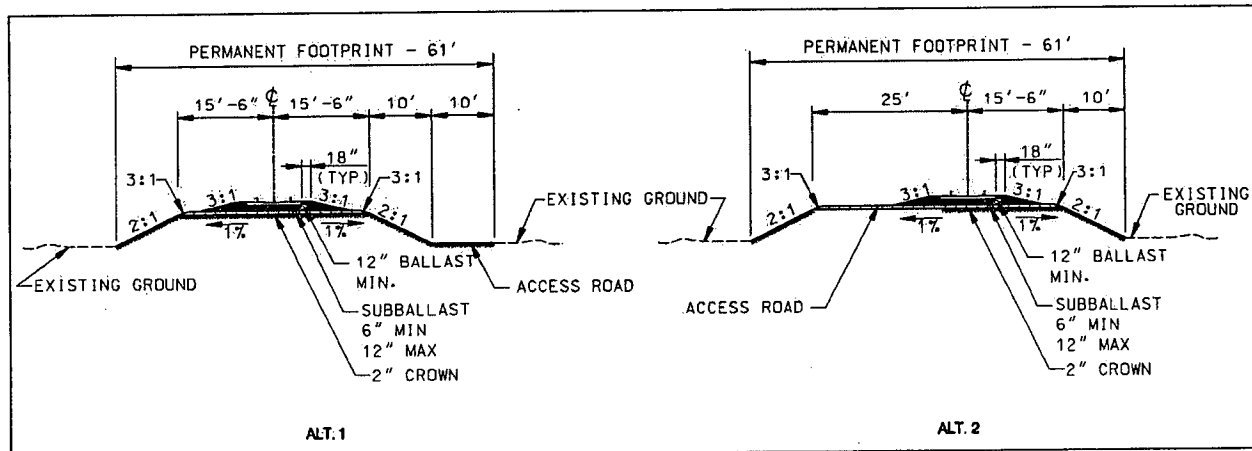


Figure F-1. Standard Embankment Typical Cross Section

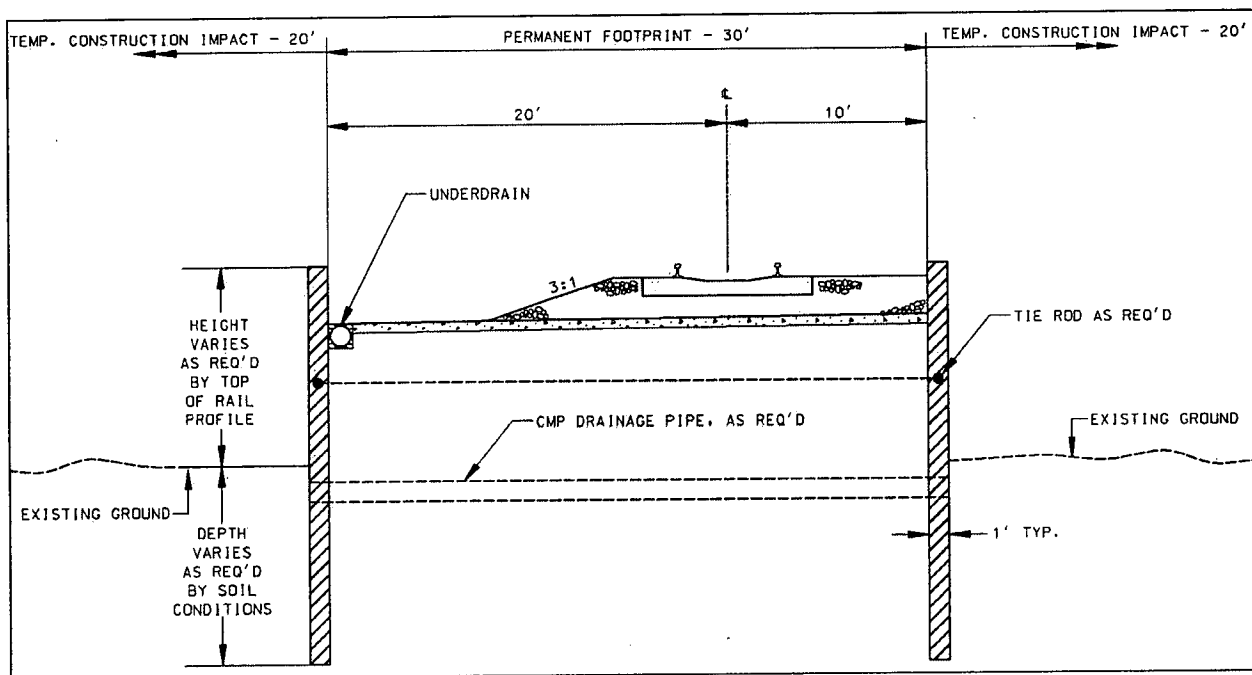


Figure F-2. Retained Fill Typical Cross Section

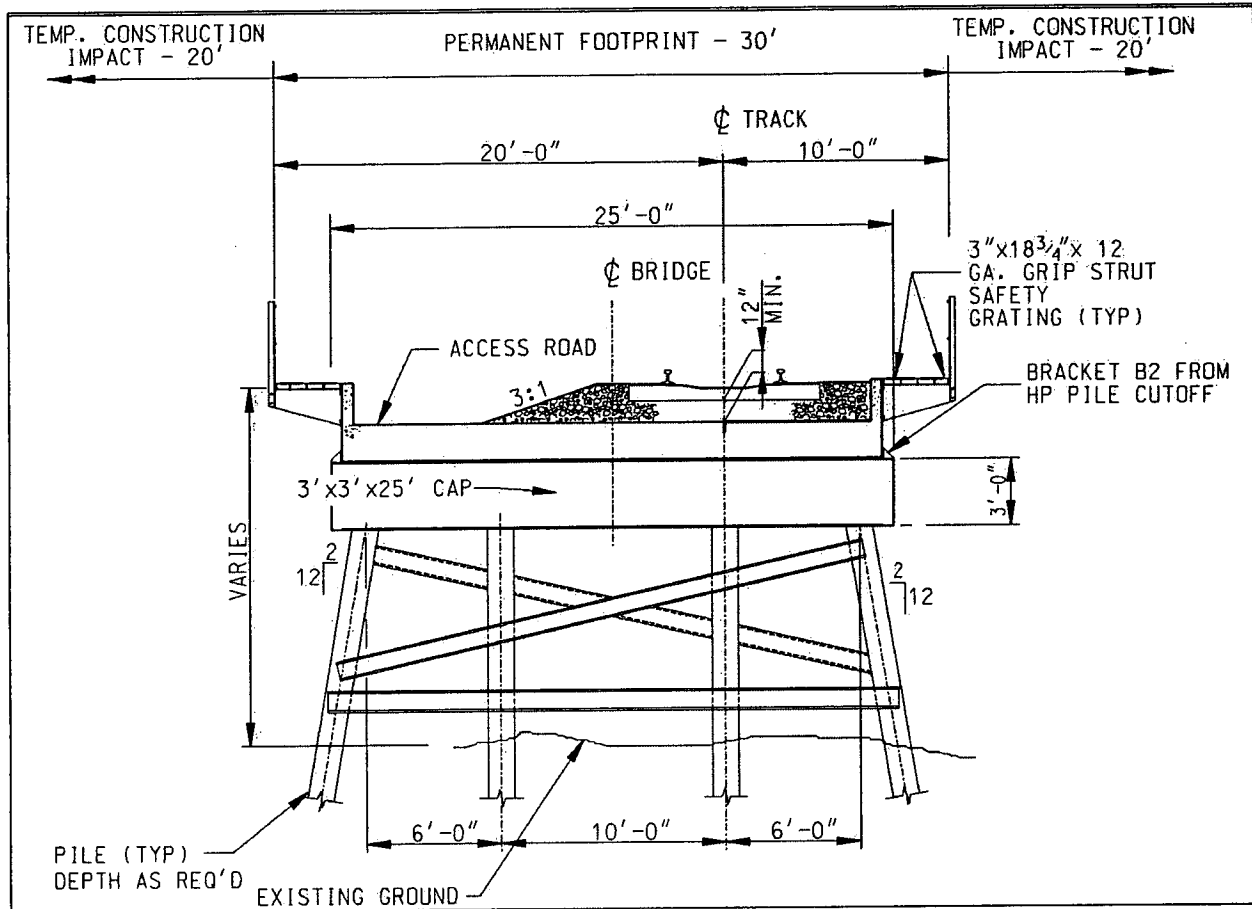


Figure F-3. Continuous Bridge Typical Cross Section

ECCLES SEGMENT

Alternate Alignment

Length: 11.50 miles

The procedures, issues, and problems related to the design of this segment are as follows:

Quantm[®] Alignment Replication: The alignment follows the Quantm[®] output with minor deviations. An interchange siding was added for pick-up and set-out along the UPRR mainline, and an interchange yard was added at Beaver Dam Road.

Tie-in Points: The Eccles connector was adjusted to accommodate a proposed siding alongside the existing UPRR tracks. The north tie-in is the same for the Caliente and Eccles segments.

Major Engineering Issues: The terrain leaving Eccles (Dutch Flat) is rough.

Major Structures: There is a bridge crossing Clover Creek, bridge widening for a proposed siding alongside the existing UPRR tracks, box culverts north of Clover Creek, a bridge across Meadow Valley Wash, and a grade separation at the US 93 crossing (see the structures table, Table D-3, for more details).

Cut/Fill Quantities and Balancing: There is more cut than fill. Areas of conventional excavation are nearly balanced. The cut quantity of areas of rippable earthwork is high, and drill and blast areas are about 95 percent cut.

Position Within the 1.0-mile BLM ALW Corridor (if applicable): The alignment is centered within the BLM ALW corridor, with minor deviations to take advantage of the new mapping and to enhance the alignment location crossing the summit north of Eccles.

Other Boundary and/or Environmental Constraints: No WSA issues exist. The alignment passes through some private properties where it crosses US 93.

Known Utility Issues: There are potential conflicts at the beginning of the Eccles alignment where it joins with the existing UPRR railroad line at Clover Creek. The impact from underground utilities is unknown.

Drainage Issues: Flash flood potential from various sources exists at Eccles. Floodplain and wetland issues may affect the yard area at Beaver Dam Road. More detailed hydraulic data are forthcoming through related work.

CS1-BENNETT

Basis for Analysis
Length: 25.57 miles

The procedures, issues, and problems related to the design of this segment are as follows:

Quantm[®] Alignment Replication: The alignment follows the Quantm[®] output, except at the beginning, where a better tie into the Caliente or Eccles segment was required.

Tie-in Points: The tie-in points were adjusted on both ends.

Major Engineering Issues: The mountain crossing at Sta. 2204+70 has sustained maximum allowable compensated grades.

Major Structures: None at present.

Cut/Fill Quantities and Balancing: Cut and fill quantities are extensive throughout the segment, and the cut-to-fill ratio is currently 2:1. The potential exists for better earthwork balance if desired in future design.

Position Within the 1.0-mile BLM ALW Corridor (if applicable): The alignment is entirely within the BLM ALW corridor and centered, with some deviations to take advantage of the new mapping and to enhance the alignment location crossing the summit of Bennett Pass.

Other Boundary and/or Environmental Constraints: No WSA issues exist, but the alignment goes through various private properties on the east side of Bennett Pass.

Known Utility Issues: High-voltage power lines run parallel to this segment over Bennett Pass; no attempt was made to avoid them. Numerous gravel and dirt roads run parallel to and cross the alignment over both the east and west sides of Bennett Pass and will require relocations to minimize at-grade crossings. There is a fiber-optic cable buried at Bennett Pass.

Drainage Issues: The alignment crosses many washes on the west sides of Bennett Pass that will require detailed hydrologic and hydraulic analyses. The alignment also may require refinements to avoid flooding through Dry Lake Valley (concerns are the low point on the west end and the proposed siding location).

CS1-PAHROC

Basis for Analysis

Length: 18.61 miles

The procedures, issues, and problems related to the design of this segment are as follows:

Quantm[®] Alignment Replication: The alignment follows the Quantm[®] output with minor deviations, except at the ending to accommodate the revised White River Bridge location.

Tie-in Points: The tie-in points were adjusted on both ends.

Major Engineering Issues: A mountain crossing at Sta. 3544+60 has sustained maximum allowable compensated grades.

Major Structures: There is a bridge and grade separation over the White River and SR 318.

Cut/Fill Quantities and Balancing: Cut and fill quantities throughout the segment are extensive and currently out of balance, with more cut. The potential exists for better earthwork balance if desired in the future design.

Position Within the 1.0-mile BLM ALW Corridor (if applicable): The alignment is entirely within the BLM ALW corridor and centered, with some deviations to take advantage of the new mapping and to enhance the alignment location crossing the summit. The centerline also moves to the north edge of the corridor from Sta. 3350+00 to Sta. 3500+00 to better avoid natural springs and archaeological sites near Sta. 3400+00.

Other Boundary and/or Environmental Constraints: None.

Known Utility Issues: None.

Drainage Issues: The alignment crosses many washes on the west side of Pahroc Summit that will require detailed hydrologic and hydraulic analyses. The alignment also may require refinements to avoid flooding through Dry Lake Valley (concerns are the low point at the east end and the proposed siding location).

CS1 – WR1 SEGMENT

Basis for Analysis

Length: 26.34 miles

The procedures, issues, and problems related to the design of this segment are as follows:

Quantm[®] Alignment Replication: The alignment follows the Quantm[®] output except at the east end to tie into the revised White River Bridge location. The horizontal alignment was refined to reduce earthwork and lower the maximum elevation.

Tie-in Points: The tie-in points were adjusted on both ends.

Major Engineering Issues: None.

Major Structures: There is a grade separation and bridge at the SR 318/White River crossing, and three other potential bridges over deep box canyons with large drainage areas.

Cut/Fill Quantities and Balancing: Cut and fill quantities throughout the segment are moderate but generally balanced between end points. Somewhat greater earthwork operations are required at the east end for the climb out of the White River Valley, where the segment crosses many side canyons.

Position Within the 1.0-mile BLM ALW Corridor (if applicable): The alignment is within the BLM ALW corridor and centered, with minor deviations.

Other Boundary and/or Environmental Constraints: A privately owned parcel lies within the BLM ALW corridor at Sta. 4870+00 but does not reach the track centerline.

Known Utility Issues: Several gravel and dirt roads that run parallel to and cross the alignment will require relocations to minimize at-grade crossings.

Drainage Issues: In general, the alignment crosses alluvial fans and follows the north flank of the Seaman Range. No special drainage problems are anticipated. More detailed hydraulic data are forthcoming through related work.

GV1 SEGMENT

Alternate Alignment

Length: 21.72 miles

The procedures, issues, and problems related to the design of this segment are as follows:

Quantm[®] Alignment Replication: The alignment deviates from the output at the east end to avoid the floodplain, and at the west end to properly transition to CS2 while reducing earthwork and elevation. A deviation from Sta. 6000+00 to Sta. 6400+00 was made to shorten the alignment length, reduce earthwork, and keep the alignment in the BLM ALW corridor. Tie-in points were adjusted on both ends.

Tie-in Points: The tie-in points were adjusted on both ends.

Major Engineering Issues: A mountain crossing exists in the vicinity of Sta. 5700+00 and at the west end, and a rock excavation in the vicinity of Sta. 5765+00.

Major Structures: None.

Cut/Fill Quantities and Balancing: The quantities are currently not in balance overall; the fill exceeds the cut by a 3:1 ratio. The quantities may be adjustable in future design, but significant fill will be necessary to place the tracks above flood levels.

Position Within the 1.0-mile BLM ALW Corridor (if applicable): The alignment was centered within the BLM ALW corridor for GV1.

Other Boundary and/or Environmental Constraints: There are no private property impacts within the BLM ALW corridor, but the alignment passes approximately within 6,300 feet of privately owned parcels at Sta. 6078+60 and within 815 feet of a privately owned parcel at Sta. 5719+00.

Known Utility Issues: None.

Drainage Issues: A floodplain exists at the east end. More detailed hydraulic data are forthcoming through related work.

GV2 SEGMENT

Alternate Alignment
Length: 22.22 miles

The procedures, issues, and problems related to the design of this segment are as follows:

Quantm[®] Alignment Replication: The alignment deviates from the Quantm[®] output at the east end to remain above the floodplain and at the west end for a better approach to Joe Barney Pass.

Tie-in Points: The tie-in points were adjusted to match adjoining segments.

Major Engineering Issues: None.

Major Structures: A bridge may be required in Water Gap.

Cut/Fill Quantities and Balancing: Overall, the quantities are out of balance, with cut exceeding fill by a 1.5:1 ratio, but are likely adjustable during future design work.

Position Within the 1.0-mile BLM ALW Corridor (if applicable): The alignment is entirely within the BLM ALW corridor for GV2 and centered, with some deviations to take advantage of the new mapping.

Other Boundary and/or Environmental Constraints: No WSA issues exist, but there are privately owned parcels 1,300 feet to the left, at Sta. 28245+28, and 2,660 feet to the right, at Sta. 28447+28.

Known Utility Issues: None.

Drainage Issues: The alignment affects numerous washes. Major drainage issue may exist at Water Gap because a very large drainage area (including a significant area in the Humboldt-Toiyabe National Forest) funnels through the narrow gap. More detailed hydraulic data are forthcoming through related work.

GV3 SEGMENT

Alternate Alignment
Length: 23.37 miles

The procedures, issues, and problems related to the design of this segment are as follows:

Quantm[®] Alignment Replication: The alignment closely follows the Quantm[®] output, with minor deviations to improve grade and earthwork.

Tie-in Points: The tie-in points were adjusted on both ends to match adjoining segments.

Major Engineering Issues: The alignment must ascend through a narrow canyon north of Water Gap.

Major Structures: None.

Cut/Fill Quantities and Balancing: Earthwork is balanced overall.

Position Within the 1.0-mile BLM ALW Corridor (if applicable): There is no BLM ALW corridor for GV3. The alignment lies within the corridor for GV1 from the point of beginning (POB) to Sta. 30060+00 and from Sta. 30900+00 to the point of ending (POE).

Other Boundary and/or Environmental Constraints: No WSA issues exist, but the alignment goes near privately owned parcels in Garden Valley. Privately owned parcels are located approximately 775 feet to the right, at Sta. 29995+60, and 3,215 feet to the right, at Sta. 30419+60.

Known Utility Issues: None.

Drainage Issues: The alignment crosses numerous washes. More detailed hydraulic data are forthcoming through related work.

GV8 SEGMENT

Basis for Analysis
Length: 22.72 miles

The procedures, issues, and problems related to the design of this segment are as follows:

Quantm[®] Alignment Replication: Deviated slightly from Quantm[®] at east end to remain above the floodplain, and more at west end (south of Quantm[®]) for an enhanced approach to Joe Barney Pass.

Tie-in Points: Adjusted tie in points to match adjoining segments.

Major Engineering Issues: Need to keep the alignment high enough along the entire segment to avoid potential flooding.

Major Structures: Bridge may be required in Water Gap.

Cut/Fill Quantities and Balancing: Out of balance overall with cut exceeding fill by 1.4:1 ratio, but likely adjustable during future design work.

Position Within the 1.0-mile BLM ALW Corridor (if applicable): No BLM ALW corridor exists for GV8; the alignment is within the GV2 corridor except from Sta. 56467+92 to Sta. 56806+47. Within the GV2 corridor, GV8 stays to the north on the east end and to the south on the west end to better avoid privately owned parcels.

Other Boundary and/or Environmental Constraints: No WSA issues; there are privately owned parcels 1,050 feet to the left at Sta. 56227+50 and 4,370 feet to the right at Sta. 56431+95.

Known Utility Issues: None.

Drainage Issues: Alignment affects numerous washes. Major drainage issue may exist at Water Gap since a very large drainage area (including a significant area in the Humboldt-Toiyabe National Forest) funnels through the narrow gap. More detailed hydraulic data are forthcoming through related work.

CS2 – East SEGMENT

Basis for Analysis
Length: 23.06 miles

The procedures, issues, and problems related to the design of this segment are as follows:

Quantm[®] Alignment Replication: The alignment was shifted southward from Sta. 7050+00 to Sta. 7300+00 to decrease the length of steeper grades.

Tie-in Points: The tie-in points were adjusted on both ends.

Major Engineering Issues: None.

Major Structures: None.

Cut/Fill Quantities and Balancing: Earthwork throughout this segment is moderate and balanced overall. The alignment deviates northward to avoid archaeological sites from Sta. 7300+00 to Sta. 7425+00, with slightly increased fill along that length.

Position Within the 1.0-mile BLM ALW Corridor (if applicable): The alignment is centered within the BLM ALW corridor, with the minor deviations noted above.

Other Boundary and/or Environmental Constraints: The design now avoids the archaeological sites denoted above by shifting the alignment 1,500 feet to 2,000 feet upslope to the north.

Known Utility Issues: None.

Drainage Issues: No significant issues. More detailed hydraulic data are forthcoming through related work.

CS2 – West SEGMENT

Basis for Analysis

Length: 7.58 miles

The procedures, issues, and problems related to the design of this segment are as follows:

Quantm[®] Alignment Replication: The alignment follows the Quantm[®] output closely, with minor deviations.

Tie-in Points: The tie-in points on both ends.

Major Engineering Issues: None.

Major Structures: A grade separation at Sta. 7640+00 elevates SR 375; the railroad remains at or near the original ground level.

Cut/Fill Quantities and Balancing: There are no significant cuts or fills; the earthwork is balanced between segment endpoints.

Position Within the 1.0-mile BLM ALW Corridor (if applicable): The alignment is centered within the BLM ALW corridor.

Other Boundary and/or Environmental Constraints: None.

Known Utility Issues: None.

Drainage Issues: None; more detailed hydraulic data are forthcoming through related work.

SR2 SEGMENT

Alternate Alignment

Length: 11.71 miles

The procedures, issues, and problems related to the design of this segment are as follows:

Quantm[®] Alignment Replication: The alignment follows the Quantm[®] output; however, the horizontal alignment was refined to eliminate Quantm[®] alignment deviations up and down contours, curves were reworked through hills near Sta. 36150+00, and the alignment was moved southwest at Sta. 36180+00 to avoid WSA impacts.

Tie-in Points: The tie-in points were adjusted on both ends.

Major Engineering Issues: None.

Major Structures: None.

Cut/Fill Quantities and Balancing: The cut-to-fill ratio is higher than 2:1 by design; the potential for balancing quantities exists for future work.

Position Within the 1.0-mile BLM ALW Corridor (if applicable): The alignment follows the southern parts of the BLM ALW corridor to avoid WSAs while staying within corridor. It leaves the BLM ALW corridor (and is between the SR2 and SR3 alignment segments) for 4,500 feet at Sta. 36270+00 to take advantage of the topography. The alignment rejoins the BLM ALW corridor prior to meeting the SR3 alternative.

Other Boundary and/or Environmental Constraints: The alignment runs close to and parallel to a WSA between Sta. 36000+00 and Sta. 36200+00 with earthwork between the WSA boundary and hills.

Known Utility Issues: Several gravel and dirt roads which run parallel to and cross the alignment will require relocation to minimize at-grade crossings.

Drainage Issues: The crossing at Sta. 36220+00 needs to be resolved. More detailed hydraulic data are forthcoming through related work.

SR3 SEGMENT

Basis for Analysis
Length: 12.31 miles

The procedures, issues, and problems related to the design of this segment are as follows:

Quantm[®] Alignment Replication: The alignment follows the Quantm[®] output; however, the horizontal alignment was refined to eliminate Quantm[®] deviations up and down contours, curves were reworked through hills near Sta. 8320+00, and the alignment was moved southwest at Sta. 8050+00 to avoid WSA impacts.

Tie-in Points: The tie-in points were adjusted on both ends.

Major Engineering Issues: None.

Major Structures: None.

Cut/Fill Quantities and Balancing: Cut quantities are high (2:1 ratio), but adjustable in future design work.

Position Within the 1.0-mile BLM ALW Corridor (if applicable): The alignment is centered within the corridor from the beginning up to Sta. 8350+00; it lies closer to the south BLM boundary up to Sta. 8400+00 to take advantage of topography.

Other Boundary and/or Environmental Constraints: The alignment runs close to and parallels a WSA between Sta. 8000+00 and Sta. 8170+00, but earthwork along this section is minimal; the NTTR is close to the current alignment at Sta. 8380+00.

Known Utility Issues: Several gravel and dirt roads run parallel to and cross the alignment, and will require relocation to minimize at-grade crossings.

Drainage Issues: A drainage crossing issue at Sta. 8340+00 needs to be resolved. More detailed hydraulic data are forthcoming through related work.

CS3 SEGMENT**Basis for Analysis**
Length: 69.97 miles

The procedures, issues, and problems related to the design of this segment are as follows:

Quantm[®] Alignment Replication: The alignment follows the Quantm[®] output very closely. The radii of a few horizontal curves in the vicinity of Sta. 9550+00 and near Warm Springs Summit were increased to improve railroad performance and maintenance characteristics.

Tie-in Points: Tie-in points was adjusted on both ends of the segment.

Major Engineering Issues: The mountain crossing at Warm Springs Summit (Sta. 9994+00) requires a limiting, compensated (1.96 percent) profile grade on the eastern approach to the summit. Significant excavation is unavoidable in this area. A proposed siding near Sta. 9600+00 is in an area where significant fill is required; it may be necessary to consider moving the siding farther south.

Major Structures: The alignment includes a proposed maintenance-of-way facility at Sta. 11400+00 and possible bridges at Sta. 9660+00 (Cow Canyon), Sta. 10570+00, and Sta. 9593+00.

Cut/Fill Quantities and Balancing: Earthwork is generally balanced between segment endpoints. Cut volumes exceed fill volumes at Warm Springs Summit, as described above. Cut volumes also exceed fill volumes in an area of sharp undulating terrain of CS3/east approaching Warm Springs Summit, in an attempt to minimize bridge costs and the use of sharp curves.

Position Within the 1.0-mile BLM ALW Corridor (if applicable): The alignment is entirely within the BLM ALW corridor and centered, with some deviations to take advantage of the new mapping.

Other Boundary and/or Environmental Constraints: The Clifford Mine (a historic property) is within the BLM ALW corridor near Sta. 10125+00. According to available mapping, the mine site appears to be about 0.5 mile southeast of the proposed rail alignment.

Known Utility Issues: The alignment is parallel to and approximately 200 feet away from US 6 from Sta. 9900+00 to Sta. 9980+00 and may impact existing Nevada Department of Transportation property. Various gravel and dirt roads run parallel to and cross the alignment throughout this segment. Relocation of some roads is necessary to minimize at-grade crossings. High-voltage power lines cross the alignment near Sta. 11730+00.

Drainage Issues: Potential low areas east of Mud Lake may require extra fill to raise the alignment above flood levels. More detailed hydraulic data are forthcoming through related work.

GF1 SEGMENT

Alternate Alignment

Length: 29.30 miles

The procedures, issues, and problems related to the design of this segment are as follows:

Quantm[®] Alignment Replication: The alignment follows the Quantm[®] output from the beginning to Sta. 12970+00. From Sta. 12970+00 to Sta. 13650+00, it follows the previous engineered alignment, a better alternative using the 5-foot contour topography. From Sta. 13650+00 to the end, the alignment varies from the Quantm[®] output and extends to the east to cross a channel at Sta. 13797+71 at a reduced angle.

Tie-in Points: The tie-in points were adjusted on both ends.

Major Engineering Issues: The alignment includes a mountain crossing at Sta. 13100+00, extensive curvature (south of the summit), and sustained maximum allowable compensated grades (north and south of summit).

Major Structures: None at present, but several or more are likely.

Cut/Fill Quantities and Balancing: Cut and fill quantities are significant; cut quantities exceed fill quantities.

Position Within the 1.0-mile BLM ALW Corridor (if applicable): The alignment is entirely within the BLM ALW corridor for GF1 but is not centered. Many deviations were made to take advantage of the new mapping and to better cross mountainous terrain. The alignment touches the BLM ALW corridor boundary at Sta. 13160+00, Sta. 13430+00, and Sta. 13720+00, and goes outside the corridor for 6,000 feet at Sta. 13750+00 to reduce the angle of a major channel crossing.

Other Boundary and/or Environmental Constraints: The alignment passes close to or through numerous privately owned parcels between Sta. 12950+00 and Sta. 13250+00; most of these appear related to mining claims and/or activity. The potential impact on historic archaeological features (related to mining) appears moderate.

Known Utility Issues: None.

Drainage Issues: None; more detailed hydraulic data are forthcoming through related work.

GF3 SEGMENT

Basis for Analysis
Length: 31.08 miles

The procedures, issues, and problems related to the design of this segment are as follows:

Quantm[®] Alignment Replication: The alignment deviates significantly from the Quantm[®] output to refine the alignment, to accommodate design criteria (tangents instead of multiple reverse curves), and to follow contours (such as at Sta. 52250+00). From Sta. 52500+00 to Sta. 53400+00, the alignment is a combination of the Quantm[®] output and the prior engineered alignment to optimize design. From Sta. 53400+00 to the end, the alignment varies from the Quantm[®] output and extends to the east to cross a channel at Sta. 53556+60 at a reduced angle.

Tie-in Points: The tie-in points were adjusted on both ends.

Major Engineering Issues: The alignment includes a mountain crossing at Sta. 52733+73, extensive curvature (south of the summit), and sustained maximum allowable compensated grades (north and south of the summit).

Major Structures: None at present, but several or more are likely.

Cut/Fill Quantities and Balancing: Quantities are significant; fill quantity is higher by 2:1, but adjustable during future design.

Position Within the 1.0-mile BLM ALW Corridor (if applicable): There is no defined GF3 corridor. The GF3 alignment lies within the GF1 corridor from POB to Sta. 52200+00 and from Sta. 52910+00 to POE, except for a 2,000-foot length at Sta. 53190+00 and a 6,000-foot length at Sta. 53500+00.

Other Boundary and/or Environmental Constraints: The alignment passes close to or through a few privately owned (likely mining) parcels between Sta. 52650+00 and Sta. 52960+00. The potential impact on historic archaeological features (related to mining) is low.

Known Utility Issues: None.

Drainage Issues: None; more detailed hydraulic data are forthcoming through related work.

GF4 SEGMENT

Alternate Alignment

Length: 32.64 miles

The procedures, issues, and problems related to the design of this segment are as follows:

Quantm[®] Alignment Replication: The alignment follows the Quantm[®] segment closely, except from Sta. 42350+00 to Sta. 42500+00 (to optimize design) and from Sta. 43470+00 to the end (to cross a channel at Sta. 43639+00 at a reduced angle).

Tie-in Points: The tie-in points were adjusted on both ends.

Major Engineering Issues: The alignment includes mountain crossings (with high point at Sta. 42975+00) and sustained maximum allowable compensated grades (north and south of the summit).

Major Structures: Four or more are required, including two grade separations across US 95.

Cut/Fill Quantities and Balancing: Cut and fill quantities are significant; the fill ratio is higher but adjustable during future design.

Position Within the 1.0-mile BLM ALW Corridor (if applicable): There is no defined GF4 corridor. The GF4 alignment lies within the GF1 corridor from POB to Sta. 42150+00 and from Sta. 43405+00 to POE.

Other Boundary and/or Environmental Constraints: The alignment passes close to or through numerous privately owned parcels between Sta. 42700+00 and Sta. 43130+00. The potential to impact historic structures and mining features within and near the town of Goldfield is very high.

Known Utility Issues: None.

Drainage Issues: The alignment crosses washes that require detailed hydrologic and hydraulic analyses; two new bridges may be needed. More detailed hydraulic data are forthcoming through related work.

CS4 SEGMENT

Basis for Analysis

Length: 7.15 miles

The procedures, issues, and problems related to the design of this segment are as follows:

Quantm[®] Alignment Replication: The alignment follows the Quantm[®] output closely, with refinements added to improve the horizontal and vertical geometry.

Tie-in Points: The tie-in points were adjusted on both ends.

Major Engineering Issues: Stonewall Flat was avoided to prevent potential flooding.

Major Structures: None.

Cut/Fill Quantities and Balancing: The grading involves slightly high fill quantities, but the quantities of both cut and fill are minor and generally are balanced between segment endpoints.

Position Within the 1.0-mile BLM ALW Corridor (if applicable): The alignment is within the BLM ALW corridor but not centered; it is offset to the west side to take advantage of new mapping and to fine-tune the profile.

Other Boundary and/or Environmental Constraints: The historic site of Ralston is adjacent to alignment at Sta. 13900+00. The alignment parallels a historic railroad grade from Sta. 13881+89 to Sta. 14050+00.

Known Utility Issues: None.

Drainage Issues: Stonewall Flat and the downstream crossing at Sta. 14100+00 have the potential for flooding and need additional study. More detailed hydraulic data are forthcoming through related work.

BC2 SEGMENT

Alternate Alignment

Length: 12.54 miles

The procedures, issues, and problems related to the design of this segment are as follows:

Quantm[®] Alignment Replication: The engineered alignment follows the Quantm[®] output closely. Refinements were added to improve the horizontal and vertical geometry for the purpose of limiting the lengths of the drainage channel crossings and avoiding being directly in the channel.

Tie-in Points: The tie-in points were adjusted on both ends.

Major Engineering Issues: The NTTR boundary posed a significant constraint from Sta. 44180+00 to Sta. 44320+00 and forced the alignment to go through large rock cuts. A particular challenge was to avoid entering NTTR, limit the volume of excavation, avoid filling the drainage channel, and maintain a grade of -1.5 percent. The alignment mimics the wash, with a negative or zero grade throughout the segment. Keeping a minimum of 8 feet from the top of the rail to the bottom of the channel to preserve small drainages resulted in an imbalance in the grading quantities, which can be corrected by future design adjustments.

Major Structures: The possible location of a bridge is over the wash at Sta. 44255+00 instead of a 60-foot-high fill.

Cut/Fill Quantities and Balancing: The grading is out of balance overall. Fill quantities are high to remove undulations in the profile and allow for assumed drainage requirements, but adjustments may be possible during future design work.

Position Within the 1.0-mile BLM ALW Corridor (if applicable): The alignment is centered, with one significant deviation. It goes outside of the BLM ALW corridor (to the west) from Sta. 44280+00 to Sta. 44440+00 to take advantage of topography and to avoid intrusions into NTTR property.

Other Boundary and/or Environmental Constraints: The alignment runs almost parallel to the NTTR boundary (but does not impinge on the boundary) between Sta. 44250+00 to Sta. 44320+00; the closest point is near Sta. 44310+00, approximately 340 feet from NTTR. Rugged terrain, with significant rock cuts, prohibits realignment farther away from NTTR.

Known Utility Issues: None.

Drainage Issues: Between Sta. 44198+00 to Sta. 44330+00, large cuts and fills are necessary to maintain the grade. Some of the small drainages are in cut sections, but interceptor ditches could divert this water before it enters the cut. More detailed hydraulic data are forthcoming through related work.

BC3 SEGMENT

Basis for Analysis
Length: 12.35 miles

The procedures, issues, and problems related to the design of this segment are as follows:

Quantm[®] Alignment Replication: The engineered alignment followed the Quantm[®] output in general, with refinements added to improve the horizontal and vertical geometry. From Sta. 14700+00 to the end of the segment, the alignment deviates from the Quantm[®] output to flatten out the vertical alignment, eliminate unnecessary undulations, and tie into segment CS5.

Tie-in Points: The tie-in points were adjusted on both ends.

Major Engineering Issues: The vertical alignment has a maximum grade of 1.7 percent; the horizontal alignment was adjusted to fit that constraint. Keeping a minimum of 8 feet from the top of the rail to the bottom of the channel to preserve small drainages resulted in an imbalance in the grading quantities, which can be corrected by future design adjustments.

Major Structures: None.

Cut/Fill Quantities and Balancing: The grading is out of balance overall; fill quantities are high to remove undulations in profile, but adjustments may be possible during future phases of work.

Position Within the 1.0-mile BLM ALW Corridor (if applicable): The alignment is within the BLM ALW corridor but not centered, in order to take maximum advantage of topography. The alignment also passes close to (but not outside) the corridor near Sta. 14380+00 and also near Sta. 14650+00; revisions may be possible but would increase cut quantities by going through hills.

Other Boundary and/or Environmental Constraints: None.

Known Utility Issues: None.

Drainage Issues: The large fill between Sta. 14610+00 and Sta. 14680+00 may require refinement. From Sta. 14370+00 to Sta. 14450+00, the alignment is in a low spot at Lida Valley and may also need adjustments based on potential flood risks. More detailed hydraulic data are forthcoming through related work.

CS5 SEGMENT:**Basis for Analysis**
Length: 24.85 miles

The procedures, issues, and problems related to the design of this segment are as follows:

Quantm[®] Alignment Replication: The engineered followed it in parts only, with refinements added to improve horizontal and vertical geometry. From the beginning of the segment to Sta. 15200+00, the alignment deviates significantly from Quantm[®] in order to flatten out the vertical alignment and eliminate unnecessary undulations. From Sta. 15600+00 to the end it deviates significantly again in order to avoid a large drainage channel and produce a smoother vertical alignment.

Tie-in Points: The tie-in points were adjusted on both ends.

Major Engineering Issues: US 95 posed a significant constraint by because of the goal not to cross it or relocate it. From Sta. 15220+00 to Sta. 15490+00 the alignment climbs up and down the hill, rather than around it with a constant grade, because the of the existing highway location constraint. An adjustment to the rail alignment summit eliminated about 5 feet of rise while preserving a minimum 500-foot separation to the highway. From Sta. 15500+00 to Sta. 15540+00 the highway location again restricted the rail alignment and led to designing two significant cuts. This area will require future studies to ensure the compatibility of the making and maintaining rock cuts as close as 300-feet from the highway. Cut size will increase as the alignment moves away from US 95. At Sta. 15510+00, fill greater than 30 feet high results from eliminating an undulating grade from Sta. 15348+25 to Sta. 15765+50. Within this range the grade is either negative or zero; outside of it the segment grade reflects either the existing ground and/or the adjacent segments. Keeping a minimum of 8 feet from top of rail to bottom of channel to preserve small drainages resulted in an imbalance in the grading quantities; future design adjustments can correct this.

Major Structures: Bridge across Tolicha Wash at Sta. 15370+00.

Cut/Fill Quantities and Balancing: The grading is out of balance overall and heavy on fill by a 2:1 ratio although this is not apparent when viewing the profile. Designers may be able to adjust this imbalance during future phases of work.

Position Within the 1.0-mile BLM ALW Corridor (if applicable): Mostly centered within the corridor, except for the part between Sta. 15720+00 and Sta. 15960+00 where alignment leaves BLM boundaries in order to avoid a large drainage area.

Other Boundary and/or Environmental Constraints: Privately owned parcels overlap BLM ALW corridor at Sta. 14920+00 and Sta. 15150+00. At Sta. 15150+00, the alignment is approximately 790 feet from the corner of one privately owned parcel.

Known Utility Issues: High-voltage power line crosses alignment at Sta. 15785+00; alignment runs close to and parallels US 95 between Sta. 15380+00 and Sta. 15560+00 due to adjacent hills.

Drainage Issues: The drainage pattern at Sta. 15550+00 requires further study to determine the effects of the proposed railroad on the wash and existing highway. More detailed hydraulic data are forthcoming through related work.

OV1 SEGMENT

Basis for Analysis

Length: 6.14 miles

The procedures, issues, and problems related to the design of this segment are as follows:

Quantm[®] Alignment Replication: The engineered alignment followed the Quantm[®] output closely, with refinements added to improve horizontal and vertical geometry.

Tie-in Points: The tie-in points were adjusted on both ends.

Major Engineering Issues: At Sta. 16290+00, the alignment shares an approximately 300-foot-wide passageway with the upstream drainage basin. The alignment was placed on one side of the narrow channel rather than in the center to avoid potentially damming the waterway.

Major Structures: The alignment requires two bridges in Oasis Valley, at Sta. 16327+00 and Sta. 16350+00.

Cut/Fill Quantities and Balancing: The grading is out of balance overall, and fill quantities are high (by a 10:1 ratio). The balance can be adjusted during future phases of work. The relatively flat grade of Oasis Valley from Sta. 16296+00 to Sta. 16406+00 necessitates large fill quantities for the approaches for the two bridges in order to provide adequate clearance for the drainage.

Position Within the 1.0-mile BLM ALW Corridor (if applicable): The alignment is centered within the BLM ALW corridor.

Other Boundary and/or Environmental Constraints: Privately owned parcels overlap the BLM ALW corridor from Sta. 16330+00 and Sta. 16410+00. The alignment crosses the two parcels at approximately Sta. 16354+00.

Known Utility Issues: None.

Drainage Issues: The drainage basin at the northern portion of the alignment and the channel near Sta. 16290+00 needs further investigation to determine potential impacts on/by the railroad. More detailed hydraulic data are forthcoming through related work.

OV3 SEGMENT

Alternate Alignment

Length: 8.78 miles

The procedures, issues, and problems related to the design of this segment are as follows:

Quantm[®] Alignment Replication: The engineered alignment follows the Quantm[®] output closely, with refinements added to improve horizontal and vertical geometry.

Tie-in Points: The tie-in points were adjusted on both ends.

Major Engineering Issues: None.

Major Structures: The alignment requires two bridges at Sta. 46185+00 and Sta. 46310+00.

Cut/Fill Quantities and Balancing: The grading is out of balance overall, and fill quantities are high (by almost a 10:1 ratio), although adjustments are probably possible during future phases of work.

Position Within the 1.0-mile BLM ALW Corridor (if applicable): There is no defined OV3 corridor. The OV3 alignment lies within the OV1 corridor except from Sta. 46080+00 to Sta. 46286+50.

Other Boundary and/or Environmental Constraints: Privately owned parcels and natural springs (Colson Pond) are close to the alignment.

Known Utility Issues: None.

Drainage Issues: None; more detailed hydraulic data are forthcoming through related work.

CS6 – BW1 SEGMENT

Basis for Analysis
Length: 11.13 miles

The procedures, issues, and problems related to the design of this segment are as follows:

Quantm[®] Alignment Replication: Refinements were added to improve horizontal and vertical geometry, primarily north of Beatty Wash.

Tie-in Points: The tie-in points were adjusted on both ends.

Major Engineering Issues: None.

Major Structures: A major bridge at Sta. 16703+00 is the largest on the project.

Cut/Fill Quantities and Balancing: Cut and fill quantities for this small segment are significant. Cut exceeds fill, but quantities are generally balanced over the overall length.

Position Within the 1.0-mile BLM ALW Corridor (if applicable): The alignment is within the BLM ALW corridor but not centered; it is shifted toward the west side to better use the topography and to provide for an enhanced location to cross Beatty Wash.

Other Boundary and/or Environmental Constraints: The Silicon Mine site lies within the BLM ALW corridor, at Sta. 16825+00.

Known Utility Issues: None.

Drainage Issues: The topography is very rough. The drainage along the entire segment needs to be fine-tuned during future engineering work. Data are forthcoming through related studies.

CS6 – BUSTED BUTTE SEGMENT

Basis for Analysis
Length: 20.68 miles

The procedures, issues, and problems related to the design of this segment are as follows:

Quantm[®] Alignment Replication: The alignment follows the Quantm[®] output, but refinements were added to remove alignment undulations up and down contour lines.

Tie-in Points: The tie-in points were adjusted on both ends.

Major Engineering Issues: Development of a viable connection to Yucca Mountain facilities is required at the end of the line.

Major Structures: The alignment includes a proposed end-of-line facility at Sta. 18140+00 and a connection to Geologic Repository Operating Area at Sta. 18190+00.

Cut/Fill Quantities and Balancing: Significant cut and fill quantities are required, with a cut-to-fill ratio of 2:1; earthwork will change based on ultimate re-design of alignment at the end of the line.

Position Within the 1.0-mile BLM ALW Corridor (if applicable): The alignment is within the BLM ALW corridor and centered, with some deviations to take advantage of the new mapping, from POB to Sta. 17850+00. From there, the alignment varies in location within the BLM ALW corridor to allow for an enhanced approach to the end-of-line facility.

Other Boundary and/or Environmental Constraints: NTTR overlaps the BLM ALW corridor at Sta. 17260+00.

Known Utility Issues: None.

Drainage Issues: The topography is very rough, and drainage along the entire segment needs to be fine-tuned during future engineering work. More detailed hydraulic data are forthcoming through related work.